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Audit Report

OFFICE OF THE INSPECTOR GENERAL

REQUIREMENTS PLANNING AND IMPACT ON READINESS OF TRAINING SIMULATORS AND DEVICES

Report No. 97-138

April 30, 1997

Department of Defense

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Acronyms

ACAT	Acquisition Category
ACTD	Advanced Concept Technology Demonstration
ASD(C^3I)	Assistant Secretary of Defense (Command, Control, Communications, and Intelligence)
ATS	Aircrew Training System
BFTT	Battle Force Tactical Trainer
CCTT	Close Combat Tactical Trainer
DIS	Distributed Interactive Simulation
FSCATT	Fire Support Combined Arms Tactical Trainer
JSIMS	Joint Simulation System
MAIS	Major Automated Information System
NAWCTSD	Naval Air Warfare Center Training Systems Division
OIPT	Overarching Integrated Product Team
OPTEMPO	Operating Tempo
SIMNET	Simulation Network
STOW	Synthetic Theater of War
STRICOM	Simulation, Training, and Instrumentation Command
WARSIM	Warfighter's Simulation

INSPECTOR GENERAL
DEPARTMENT OF DEFENSE
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April 30, 1997

MEMORANDUM FOR UNDER SECRETARY OF DEFENSE FOR ACQUISITION AND TECHNOLOGY
UNDER SECRETARY OF DEFENSE FOR PERSONNEL AND READINESS
ASSISTANT SECRETARY OF DEFENSE (COMMAND, CONTROL, COMMUNICATIONS, AND INTELLIGENCE)

SUBJECT: Audit Report on Requirements Planning and Impact on Readiness of Training Simulators and Devices (Report No. 97-138)

We are providing this report for your information and use. Comments on the draft report were considered in preparing this final report and are included in Part III, "Management Comments."

Comments on the draft of this report conformed to the requirements of DoD Directive 7650.3 and left no unresolved issues. Therefore, no additional comments are required.

We appreciate the courtesies extended to the audit staff. Questions on the audit should be directed to Mr. Raymond A. Spencer, Audit Program Director, at (703) 604-9071 (DSN 664-9071) or Mr. David F. Vincent, Audit Project Manager, at (703) 604-9058 (DSN 664-9058). See Appendix H for the report distribution. The audit team members are listed inside the back cover.

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Office of the Inspector General, DoD

Report No. 97-138 **April 30, 1997**
(Project No. 5AB-0070.00)

Requirements Planning and Impact on Readiness of Training Simulators and Devices

Executive Summary

Introduction. Computer training simulations consist of hardware and software designed to show a concept or to simulate an operational environment for training purposes. Overall acquisition of training systems by the Military Departments now exceeds $1.5 billion per year. The Army Close Combat Tactical Trainer is estimated to cost more than $1 billion. The following two types of simulation exist:

o System-specific computer training simulations support training for a specific weapon system. For example, the Army AH-64 Mission Simulator trains for in-flight and weapons delivery, emergency procedures, and sensor system operations.

o Non-system specific computer training simulations can support training for a single, specific weapon or equipment system. The Army Close Combat Tactical Trainers will simulate the integrated performance of a variety of weapon systems.

Audit Objectives. The audit objectives were to evaluate the acquisition process for training simulators, computer training simulations, training devices, and adequacy of the management control program as it applied to the primary audit objective.

Audit Results. The Executive Council for Modeling and Simulation, the Defense Modeling and Simulation Office, and the Modeling and Simulation Training Council have improved development and management of simulations. Also, the Army and the Navy successfully cooperated in developing and acquiring computer training simulations (Finding D). However, three conditions warrant management action.

o The DoD is developing and procuring large-scale (involving interoperable simulators and wargames, and live ranges) computer training simulations without adequate control and oversight. As a result, DoD senior management has not received Major Automated Information System quarterly reporting and has not conducted milestone decision reviews for the large-scale training simulations (Finding A).

o The Defense Advanced Research Projects Agency and the Joint Staff have investment plans to develop redundant, joint computer training simulations. Establishing an overarching integrated product team to prevent redundant programs will put about $209.3 million to better use (Finding B).

o The Army, the Navy, and the Air Force have not shown that large-scale computer training simulations are effective. As a result, DoD invested more than $1.6 billion in large-scale computer training simulations that have not been proven to enhance training and could instead adversely affect readiness (Finding C).

Implementation of the recommendations in this report will improve the effectiveness and efficiency of computer training simulation and device acquisitions. See Appendix A for details on the management control program.

Summary of Recommendations. We recommend that management do the following:

o Establish acquisition oversight of large-scale training systems and define the acquisition category and milestone decision authority for the systems.

o Clarify the scope of an automated information system and define specifically the size and type of systems that are under the cognizance of the Under Secretary of Defense for Acquisition and Technology and under cognizance of the Assistant Secretary of Defense (Command, Control, Communications, and Intelligence).

o Implement policy to ensure that the designated milestone decision authority for large-scale training simulations have appropriate, independent oversight.

o Establish the appropriate involvement of subject matter experts in exercising oversight of large-scale training simulations and systems of systems.

o Establish an Overarching Integrated Product Team and validate the requirements for the Synthetic Theater of War Advanced Concept Technology Demonstration and the Joint Simulation System program.

o Develop policy and procedures for evaluating the training effectiveness and cost-effectiveness of large-scale training simulations.

Management Comments. The Under Secretary of Defense for Acquisition and Technology coordinated his response with the Under Secretary of Defense for Personnel and Readiness and the Assistant Secretary of Defense (Command, Control, Communications, and Intelligence). The Under Secretary agreed in principle with the need for better oversight of training simulation acquisitions. Although they do not agree with each of the findings and recommendations, they were committed to taking actions to improve simulation management, support, and effectiveness across all DoD Components. The Under Secretary designated selected training simulation acquisitions as "Special Interest," delegated their management and oversight to DoD Components, initiated a program reporting mechanism, and directed program reviews by a Defense Review Team. The full text of the comments is in Part III.

Audit Response. The policy and strategy implemented by the Under Secretary of Defense for Acquisition and Technology to manage and oversee the acquisition of large-scale training systems is responsive to the intent of the recommendations. No further comments are required.

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Part I - Audit Results

Audit Background

DoD has a limited capability to create synthetic environments by building systems of systems[1] that link together simulations; weapon system simulators; instrumented ranges; command, control, communications, computer, and intelligence systems; mission-planning systems, and "live" weapon system platforms. (Appendix C is a glossary of the technical terms used in this report.) This capability can be used for a variety of applications, including training. The trend in linking training simulations will accelerate as DoD increases the interoperability and reuse of simulations by establishing a DoD standard, common technical framework, such as a high-level architecture.

The Executive Council for Modeling and Simulation is the advisory forum for application and control of modeling and simulation, providing recommendations to the Under Secretary of Defense for Acquisition and Technology on DoD modeling and simulation goals, objectives, and investment strategy. The Executive Council for Modeling and Simulation oversees development of DoD modeling and simulation plans, programs, policies, and procedures. The Defense Modeling and Simulation Office serves as the DoD focal point for modeling and simulation. The Defense Modeling and Simulation Office also serves as the Executive Secretariat for the Executive Council for Modeling and Simulation and facilitates the Acquisition Task Force on Modeling and Simulation meetings, disseminates policy and guidance to the Military Departments, and maintains the Defense Modeling and Simulation Information System.

Simulation is categorized as live, virtual, and constructive.

- Live simulation involves real people operating real systems.

- Virtual simulation involves real people operating simulated systems. Virtual simulations involve people in a central role exercising motor control skills (for example, flying an airplane), decision skills (for example, committing fire control resources to action), or communication skills (for example, as a member of a command, control, communications, computers, and intelligence team).

- Constructive simulation involves simulated people operating simulated systems. Real people stimulate (make inputs to) such simulations, but are not involved in determining the outcomes.

[1]Systems of systems are also known as federations.

The use of simulation for training, from the individual level to large-scale, joint (inter-Service) exercises has become a widely accepted practice. About 15 years ago, the term "simulation" referred almost entirely to devices used for individual training of tasks. Today, advances in high-speed, communication networks and high-performance computers have made possible the use of Distributed Interactive Simulation (DIS) for collective training at all levels, including joint training and readiness. Collective training refers to development of the skills needed to operate individually or as part of a crew or team. DoD is moving away from the large, stand-alone simulation systems to the advanced development of collective simulations using DIS for joint and combined (inter-allied) training. The DIS allows different types of simulators in various locations to operate in a common, synthetic battlefield. See Appendix D for a summary of training simulations reviewed during the audit.

Training simulations in DoD have historically been defined as part of a weapon system. However, as technology has evolved, computer training simulations are not dedicated to or essential in real time to the mission performance of any single weapon or equipment system.

Funds for training exercises are being reduced because of cost and environmental factors. Reductions in the Defense budget and in force structure increase the difficulty of sustaining military readiness to deal with less predictable adversaries in less obvious places.

Audit Objectives

The primary audit objective was to evaluate the acquisition process for training simulators, devices, and simulations. Specifically, we determined whether requirements planning and development, test, and evaluation of training simulators, computer simulations, and devices were adequately considered in the acquisition process; determined whether meaningful test and evaluation requirements for training simulators and devices were incorporated into the test and evaluation master plan; determined whether comprehensive economic analyses are considered as part of the decision process; and evaluated the impact of training simulators, computer simulations, and devices on the operational readiness of the Military Departments, including the National Guard and Reserves. Additionally, we determined whether requirements were adequately supported and documented before simulators and devices were developed. We also evaluated the adequacy of the management control program as it applied to the primary audit objective.

See Appendix A for a discussion of the scope and methodology, the review of the management control program, and the organizations visited or contacted during the audit. See Appendix B for a summary of prior coverage related to the audit objectives.

Finding A. Oversight of Computer Training Simulation Acquisition Programs

The DoD is developing and procuring large-scale computer training simulations without adequate control and oversight. Control and oversight are lacking because DoD has not assigned a single manager the responsibility and authority for oversight and coordination of large-scale training simulations. As a result, DoD senior management and decision makers have not received Major Automated Information System (MAIS) quarterly reporting and have not conducted milestone decision reviews for large-scale training simulations.

Types of Computer Training Simulations

Increased Emphasis on Computer Simulation. DoD plans call for an increased emphasis on computer simulation to aid in linking large-scale training exercises and in the testing and evaluation of new weapon systems. Since the 1960's, hardware costs have significantly decreased and software development, acquisition, and maintenance costs have increased. DoD spends about $42 billion a year on software. Typically, actual costs for developing software are double their expected costs because of a lack of clear requirements and acquisition development milestones to indicate whether projects are on time and on budget.

Computer training simulations are hardware and software designed to demonstrate or simulate an operational environment in order to practice specific training goals and objectives. For example, training simulations are used for initial familiarization in the operation and maintenance of simple equipment (for example, radio or compass) or complex equipment (for example, an engine in an aircraft, an over-heating boiler, or fire equipment on a ship). The two major categories of training simulations follow.

o System-specific training simulations that support training for a specific weapon system. For example, the Army's AH-64 helicopter Mission Simulator provides in-flight and weapons delivery, emergency procedures, and sensor system operations training.

o Non-system specific training simulations also support training and can support multiple weapon or equipment systems. For example, the Army's Combined Arms Tactical Trainer simulates the integrated performance of a variety of weapon systems for collective training purposes.

Modeling and Simulation Oversight. The DoD Executive Council for Modeling and Simulation and the Defense Modeling and Simulation Office operate under the Office of the Under Secretary of Defense for Acquisition and Technology (USD[A&T]). The Modeling and Simulation Training Council has also been established for training simulations. They have improved the development process and management of simulations. However, additional improvements are needed.

The Defense Modeling and Simulation Office has played a key role in developing strategy, providing technical direction, and establishing standards for DoD modeling and simulation efforts. However, the Executive Council for Modeling and Simulation and the Defense Modeling and Simulation Office have been unable to provide the needed oversight of large-scale training simulation programs. For example, the Army Close Combat Tactical Trainer was designated as an Army Acquisition Category (ACAT) II program, with the Commander, Simulation, Training, and Instrumentation Command, delegated as the Milestone Decision Authority.

Revised Acquisition Directives and Instructions

DoD Directive 1430.13, "Training Simulators and Devices," August 22, 1986, authorizes the DoD to use training simulators and devices to make training systems more effective and to help maintain military readiness. DoD Directive 5000.59, "DoD Modeling and Simulation Management," January 4, 1994, establishes DoD policy, assigns responsibilities, and prescribes procedures for the management of modeling and simulation. DoD Directive 5000.59 also establishes both the Defense Modeling and Simulation Office and the DoD Executive Council for Modeling and Simulation.

MAIS Acquisition Programs. DoD Directive 5000.1, "Defense Acquisition," March 15, 1996, establishes the guiding principles for all DoD acquisitions ranging from advanced fighter aircraft to the simplest combat helmet. DoD Regulation 5000.2-R, "Mandatory Procedures for Major Defense Acquisition Programs (MDAPS) and Major Automated Information System (MAIS) Acquisition Programs," March 15, 1996, specifies mandatory policies and procedures for managing DoD and MAIS acquisition programs. DoD Regulation 5000.2-R requires management to structure an MAIS acquisition to ensure a logical progression through a series of phases that are designed to reduce risk, ensure affordability, and provide adequate information for decisionmaking.

DoD Regulation 5000.2-R defines MAIS acquisition programs as:

> A combination of computer hardware and software, data, or telecommunications, that performs functions such as collecting, processing, transmitting, and displaying information. Excluded are computer resources, both hardware and software, that are physically part of, dedicated to, or essential in real time to the mission performance of weapons systems.[2]

DoD Regulation 5000.2-R also requires quarterly reporting on MAISs and states, in part:

> The quarterly MAIS Status Reporting System is designed to provide senior management at the Component and OSD (Office of the Secretary of Defense) levels with the program status, progress, issues, risks, and risk reducers. The quarterly report is essential to the early identification of problems and associated plans to initial corrective actions. It is also essential the report is provided to the Milestone Decision Authority in a timely manner to permit prompt action to address reported issues and problems. DoD Regulation 5000.2-R also requires the responsible DoD Component to notify the (USD[A&T]) or the Assistant Secretary of Defense (Command, Control, Communications, and Intelligence) (ASD[C^3I]) when cost growth or a change in acquisition strategy results in raising the classification of a formerly lower cost acquisition category (ACAT) program to an ACAT-I or IA program.

DoD Regulation 5000.2-R also requires the responsible DoD Component to notify the USD(A&T) or the Assistant Secretary of Defense (Command, Control, Communications, and Intelligence) (ASD[C^3I]) when cost growth or a change in acquisition strategy results in raising the classification of a formerly lower cost ACAT program to an ACAT-I or IA program.

The ASD(C^3I) designates a program as an ACAT-IA MAIS program when it is estimated to require:

o program costs for any single year in excess of $30 million (FY 1996 constant dollars); or

o total program costs in excess of $120 million (FY 1996 constant dollars); or

o total life-cycle costs in excess of $360 million (FY 1996 constant dollars).

Program Cost Estimates. Various program officials gave us varying and conflicting program costs for certain programs we considered during the audit. Further, those officials gave us various definitions of programs. For the programs we reviewed, we defined program costs as inclusive of

[2]Refers to items that can be used directly by the Armed Forces to carry out combat missions.

research and development costs, procurement costs, operation and maintenance costs, and military construction costs. Table 1 shows the programs we considered and the ranges of costs.

Table 1. Program Cost Estimates

System	Estimated Cost (millions)
Close Combat Tactical Trainer(CCTT)	$693.0 to $846.0
Warfighter's Simulation (WARSIM) 2000	172.0 to 507.0
Battle Force Tactical Trainer (BFTT)	0.4 to 165.0
Joint Tactical Combat Training System (JTCTS)	6.0 to 270.0
Synthetic Theater of War Advanced Concept Technology Demonstration (STOW ACTD)	220.0 to 442.0
Joint Simulation System (JSIMS)	154.0 to 641.0
Distributed Interactive Simulation (DIS)	50.0 to 500.0

Ongoing Acquisitions of Non-System Specific Training Simulations

As the milestone decision authority for ACAT-IA MAIS acquisition programs, the ASD(C^3I) approves ACAT-IA MAIS acquisition programs for entry into the next phase. A major milestone is the decision point that separates the phases of an acquisition program. Major milestones include, for example, the decisions to authorize entry into the engineering and manufacturing development phase, or full-rate production, or to begin program definition and risk reduction.

Based on defined cost thresholds, the revised DoD Regulation 5000.2-R defines training simulations as ACAT-IA MAIS acquisition programs. Accordingly, we determined that a significant number of ongoing non-system specific training simulation acquisition programs that have not previously been defined as ACAT-IA MAIS acquisition programs should now be required to have periodic assessments and milestone decision reviews. While not all-inclusive, the training simulation acquisition programs listed in Table 2 are illustrative of the programs that now require milestone decision reviews.

Table 2. Training Simulation Acquisition Programs Meeting MAIS Threshold

System	Estimated Cost (millions)
CCTT	$846
WARSIM 2000	172
BFTT	165
MARISIM*	142
JTCTS	270
STOW ACTD	442
JSIMS (core)	154
DIS	500
Total	**$2,691**

*Maritime Simulation.

Army Close Combat Tactical Trainer. The CCTT is a collective training system in which armor and mechanized infantry units staff full-crew simulators to conduct unit training in a simulated combined arms environment. The CCTT program costs totaled about $846 million. The CCTT program was inappropriately designated an ACAT-II acquisition program and should be designated as an ACAT-1A MAIS acquisition program.

Army Warfighter's Simulation 2000. The WARSIM 2000 is a next-generation battle simulation that will be used as a replacement for the current Brigade and Battalion Simulation and Corps Battle Simulation in supporting battalion through theater-level commanders with an advanced, computer-assisted exercise system that links virtual, live, and constructive environments. The WARSIM 2000 is also the development agent for the land forces segment of the Joint Simulation Systems program. As such, WARSIM 2000 must be carefully synchronized with the Joint Simulation Systems program milestones. The WARSIM 2000 program costs totaled about $507 million. The WARSIM program was inappropriately designated an ACAT-III acquisition program and should be designated as an ACAT-1A MAIS acquisition program.

Navy Battle Force Tactical Trainer. The BFTT will provide the Navy with tactical training to maintain and assess fleet combat proficiency in all warfare areas to include joint operations. BFTT will provide training at both the single platform and the Battle Group levels. Program costs totaled about $165 million. The BFTT should be designated as an ACAT-1A MAIS acquisition program.

Navy Maritime Simulation. The Maritime Simulation program will provide the capability to conduct in-port shipboard combat system team training and at-sea exercises for training individual ships, task groups, amphibious-ready groups, battle group/task groups, and joint task forces. For example, a fleet exercise involving a single live carrier battle group may include an additional

simulated carrier battle group, simulated amphibious-ready group, and simulated Marine Expeditionary Brigade to enhance the value of the fleet exercise. Program costs totaled about $142 million; therefore, the MARISIM program should be designated an ACAT-1A MAIS acquisition program.

Navy Joint Tactical Combat Training System. The JTCTS is a joint program between the Navy and the Air Force with the Navy as lead. The JTCTS will create a virtual simulation at the battle group level in which combat participants will interact with live and simulated targets that are detected and displayed by platform sensors. Production options bring the total expected cost for the initial systems to about $270 million. Therefore, the JTCTS program should be designated an ACAT-1A MAIS acquisition program.

Synthetic Theater of War Advanced Concept Technology Demonstration. The STOW ACTD will provide a capability to simulate the actions and interactions of all entities (platforms, weapons, sensors, units, etc.) through the development of synthetic forces. The total expected cost for the STOW ACTD will be about $442 million. The STOW ACTD should be designated an ACAT-1A MAIS acquisition program.

Joint Simulation System. The JSIMS will be a core of common and joint representations providing a capability to simulate the action and interaction between entities (for example, platforms, weapons, sensors, units, etc.). The JSIMS will have a designated area of operations as influenced by the environment, system capability, and human and organizational behavior affecting the achievement of missions and objectives for that area of operations. The JSIMS is dependent on the synchronized development of air, space, land, maritime, intelligence, and other key programs in order to successfully meet their initial operational capability dates. The costs for the JSIMS program totaled about $641 million. The JSIMS program was inappropriately designated as an ACAT-II acquisition program and should be designated an ACAT-1A MAIS acquisition program.

Distributed Interactive Simulation. The primary mission of the DIS program is to define an infrastructure for linking simulations of various types at multiple locations to create realistic, complex, virtual "worlds" for the simulation of highly interactive activities. This infrastructure brings together systems built for separate purposes, technologies from different areas, and platforms from various Military Departments and permits those platforms to interoperate. Contract options bring the total expected cost for the DIS program to about $500 million. Therefore, the DIS program should be designated an ACAT-1A MAIS acquisition program.

Applicability of Criteria

Training simulations have historically been defined as part of a weapon system. However, as technology has evolved, non-system specific training simulations have been developed that are not dedicated to or essential in real time to the

mission performance of any single, specific weapon or equipment system. For example, in the case of the CCTT, it will collect information and data (through interactive crew input); will process (control the battlefield and opposing forces) information and data; will transmit (over networked communications systems to other participants and simulations) the information and data; and will display (viewers will see the battlefield and opposing forces) the information and data through the use of image generation systems.

The CCTT satisfies each of the cost thresholds, specified in DoD Regulation 5000.2-R, to be characterized as an ACAT-IA MAIS. Specifically, CCTT program costs for any single year are in excess of $30 million (FY 1996 constant dollars); CCTT total program costs are in excess of $120 million (FY 1996 constant dollars); and CCTT total life-cycle costs exceed $360 million (FY 1996 constant dollars).

Moreover, DoD Regulation 5000.2-R does not specify that the ASD(C^3I) responsibility for conducting milestone decision reviews for ACAT-IA MAIS acquisitions is limited only to systems used for command and control, communications, or intelligence activities. The definition for ACAT-IA MAIS broadly encompasses all hardware and software acquisitions exclusive of hardware and software for weapon systems.

DoD Positions on DoD Regulation 5000.2-R

Office of the Under Secretary of Defense for Acquisition and Technology. In FY 1993, the Under Secretary of Defense for Acquisition (subsequently renamed the Under Secretary of Defense for Acquisition and Technology) issued a memorandum that clearly establishes DoD policy applicable to training simulation acquisitions. The memorandum stipulates, in part:

> *Development and production of trainers for weapons systems falls clearly under the DoD Instruction 5000.2* [emphasis added]. In practice, system-specific training devices are developed and produced concurrently with the weapons system. *Non-system specific training devices are generally developed as if they are systems in their own right* [emphasis added]. No additional guidance is necessary to tell the Military Departments how to develop and produce weapons systems training devices . . . Should specific guidance be needed on training device development and production, that guidance should be included in DoD Instruction 5000.2.

DoD Regulation 5000.2-R grants the USD(A&T) broad authority to establish oversight of large-scale training simulation programs as ACAT-ID [for which the milestone decision authority is USD(A&T). The "D" refers to the Defense Acquisition Board, which advises the USD(A&T) at major decision points], or IC [for which the milestone decision authority is the DoD Component Head or, if delegated, the DoD Component Acquisition Executive. The "C" refers to Component]. However, the USD(A&T) has not used the authority accordingly.

Alternatively, the Regulation grants the ASD(C^3I) the authority to designate large-scale training simulation programs as ACAT-1A if they are considered to be MAISs.

Acquisition decision makers did not include any additional specific guidance in DoD Regulation 5000.2-R relating to training simulation acquisitions. Therefore, to exercise effective oversight of major non-system specific training simulation acquisitions, we believe that the ASD(C^3I) should review ongoing training simulation acquisitions to determine whether they need milestone decision reviews, as described in DoD Regulation 5000.2-R.

Office of the Deputy Under Secretary of Defense (Readiness). The Deputy Under Secretary of Defense (Readiness) responsibility includes, but is not limited to, reviewing and evaluating major acquisition programs related to training and readiness implications. Representatives from the Deputy Under Secretary's office disagreed with the revised DoD Regulation 5000.2-R criteria that characterized training simulations as being ACAT-1A MAISs. The representatives believed that as an alternative to the creation of a new MAIS oversight group exercising milestone decision authority over training simulation acquisitions, the DoD Training Council for Modeling and Simulation (the Council) be tasked with oversight of major training simulation acquisitions.

The Council functions as a flag officer level council for the purpose of identifying and integrating modeling and simulation requirements within the training community. The Council is the focal point for modeling and simulation activities and requirements within the training functional area. The Council focuses on modeling and simulation requirements for joint and inter-Service training. In our opinion, the authority to perform milestone decision reviews of large-scale training simulations should be at an organizational level that avoids potential conflicts of interest. Therefore, delegating the oversight of these training simulation acquisitions to the DoD Training Council for Modeling and Simulation would not provide for an appropriate level of authority for making milestone decisions. We believe that an Integrated Product Team composed of representatives from the offices of the Under Secretary of Defense for Acquisition and Technology, the Deputy Under Secretary of Defense (Readiness), and the ASD(C^3I) would be the appropriate milestone decision authority over the training simulation acquisitions.

Office of the Assistant Secretary of Defense (Command, Control, Communications, and Intelligence). The ASD(C^3I) concurs with the preliminary recommendation presented by the Inspector General, DoD, at a briefing conducted during September 1996. Specifically, this preliminary recommendation was concerned with the USD(A&T) and the ASD(C^3I) implementing the Integrated Product Team process to accomplish the recommendations for corrective action that are detailed on page 14 of this draft audit report. The DUSD(P&R) has agreed to provide functional expertise to ASD(C^3I). In keeping with acquisition reform initiatives, the ASD(C^3I) may choose to delegate oversight to the Military Departments, when appropriate. The ASD(C^3I) believes that MAIS oversight is not required for simulation advanced concept technology demonstrations.

Training Simulation Oversight

Training simulations are playing an important role in meeting DoD training requirements. However, because training simulations are software-intensive, combined with an unprecedented requirement for interoperability between different modeling and simulation systems, as well as with command, control, communications, and intelligence systems, the DoD is at an ever-increasing risk of unexpected cost overruns, schedule delays, and technical compromises relating to training simulation acquisitions. Therefore, the level of oversight afforded to training simulations should be at a level commensurate with their relative risk.

The Commander of the Army Simulation, Training, and Instrumentation Command (STRICOM) and the Commander, Naval Air Warfare Center Training Systems Division (NAWCTSD) serve as the milestone decision authority for large-scale training simulations for which they are the respective developing agency. In order for the milestone decision authority to be objective, the milestone decision authority should have an appropriate "arms-length" relationship from the developing agency. In contrast, the Commanders of STRICOM and NAWCTSD exercising milestone decision authority are in the same chain of command as the program offices responsible for the development.

The Defense Modeling and Simulation Office plays a key role in developing strategy, providing technical direction, and establishing standards, for DoD modeling and simulation efforts. However, the Executive Council for Modeling and Simulation and the Defense Modeling and Simulation Office have been unable to provide the required oversight of large-scale training simulation programs. We believe that the Defense Modeling and Simulation Office does not have enough personnel and enough personnel at the appropriate grade level to take on additional responsibilities concerning program direction and oversight. In addition, we believe that the Defense Modeling and Simulation Office is perceived as a proponent for expanded use of modeling and simulation across the DoD, and thus may not have the necessary objectivity to exercise needed oversight.

The importance of milestone decision reviews is most critical before production decisions are made. However, the DoD has not exercised adequate oversight of training simulation acquisitions as required by the revised DoD Regulation 5000.2-R; therefore, the DoD has no assurance that adequate assessments and milestone decision reviews for training simulation acquisitions will be performed in a timely, consistent, and efficient manner. The DoD needs to increase the visibility of training simulation acquisitions to ensure that Military Department investments are balanced and complementary.

Management Comments on the Finding

We provided a draft of this report on January 10, 1997. The Under Secretary of Defense for Acquisition and Technology provided a management response that was coordinated with the Deputy Under Secretary of Defense (Readiness), and the ASD(C^3I). The Under Secretary of Defense for Acquisition and Technology agreed in principle with the audit's desire for more effective oversight of training simulation acquisitions. He stated that although they do not agree with all of the findings, they were committed to taking appropriate actions to ensure a positive impact on simulation management, support, and effectiveness across all DoD Components. Instead of classifying the large scale training simulations as automated information systems and conducting milestone reviews, on February 26, 1997, the Under Secretary of Defense for Acquisition and Technology designated selected training simulation acquisitions as "Special Interest." The Under Secretary of Defense for Acquisition and Technology established a policy and strategy to manage and oversee large scale training simulations. The strategy established an Office of the Secretary of Defense Review Team to oversee and coordinate the training simulation development activities. The review team will consist of members from the offices of the Director, Defense Research and Engineering, ASD(C^3I), and the Deputy Under Secretary of Defense (Readiness). The full text of the comments is in Part III. Specific comments on each recommendation are as follows:

Recommendations, Management Comments, and Audit Response

A.1. We recommend that the Under Secretary of Defense for Acquisition and Technology and the Assistant Secretary of Defense (Command, Control, Communications, and Intelligence) coordinate to:

a. Assign a single DoD manger oversight of the acquisition of training simulation acquisition programs as well as systems of systems.

Management Comments. The Under Secretary of Defense for Acquisition and Technology concurred with the recommendation, stating that he established policy and strategy to better manage and oversee the acquisition of large-scale training simulation systems. The Under Secretary stated that he is responsible for managing modeling and simulation throughout DoD and that the Executive Council for Modeling and Simulations advises and assists him. Following an overarching integrated product team approach, the Under Secretary said that the Executive Council for Modeling and Simulations is composed of representatives from the offices of the Under Secretary of Defense for Personnel and Readiness, the Assistant Secretary of Defense (Command, Control, Communications, and Intelligence), the Director of Test Systems Engineering and Evaluation, the Chairman of the Joint Chiefs of Staff, and the Military Departments, who will oversee development of modeling and simulation policies.

b. Clarify the scope of the definition of an automated information system in DoD Regulation 5000.2-R, "Mandatory Procedures for Major

Defense Acquisition Programs (MDAPS) and Major Automated Information System (MAIS) Acquisition Programs," March 15, 1996, to define specifically the size and type of systems that are under the cognizance of the Under Secretary of Defense for Acquisition and Technology and those systems that are under the cognizance of the Assistant Secretary of Defense (Command, Control, Communications, and Intelligence).

Management Comments. The Under Secretary of Defense for Acquisition and Technology partially concurred with the recommendation, stating that information technology is used extensively in almost all modern systems, and that any definition would probably not be satisfactory to settle all questions regarding the matter. The Under Secretary further stated that the approach described in his response to Finding A and Recommendation A.1.a. provides a useful template for oversight of other classes of systems.

Audit Response. We consider the Under Secretary's comments to be responsive to the recommendation.

c. Define the acquisition category for the purpose of establishing oversight of large-scale training simulations and systems of systems.

Management Comments. The Under Secretary partially concurred with the recommendation, stating that he classified large-scale training simulations as "Special Interest," and that a Defense Review Team will periodically review them. The Under Secretary further stated that "systems of systems" are managed by domains and as such do not have an acquisition category. Additionally, the Defense Review Team and the Executive Council for Modeling and Simulation will consider the ability of the large-scale training simulations to participate in broader simulation systems of systems.

Audit Response. We consider the Under Secretary's comments to be responsive to the recommendation. No further comments are required.

d. Include the appropriate subject matter experts in exercising oversight over large-scale training simulations and systems of systems. In accordance with paragraph 5.4 of DoD Regulation 5000.2-R, Overarching Integrated Process Teams should be created with participation from subject matter experts from the Under Secretary of Defense for Personnel and Readiness, the Joint Staff, the Military Departments, and the Defense Modeling and Simulation Office.

Management Comments. The Under Secretary concurred with the recommendation, stating that the recommendation is precisely the concept behind the modeling and simulation management structure established under DoD Directive 5000.59 and that the Executive Council for Modeling and Simulation and the Defense Review Team will accomplish the recommendation.

e. Review all ongoing training simulation acquisitions and determine whether reclassification from a lower acquisition category program to an Acquisition Category-1A program is appropriate and

whether milestone decision reviews should be performed as described in DoD Regulation 5000.2-R, "Mandatory Procedures for Major Defense Acquisition Programs (MDAPs) and Major Automated Information System (MAIS) Acquisition Programs," March 15, 1996.

Management Comments. The Under Secretary concurred with the recommendation, stating that he classified the large-scale training simulations cited in our report as "Special Interest" and that a Defense Review Team will periodically review them. The Under Secretary further stated that the Defense Review Team reviews will include monitoring the performance of milestone decision reviews by the DoD Components.

A.2. We recommend that the Under Secretary of Defense for Acquisition and Technology review the role of the Executive Council for Modeling and Simulation and the Defense Modeling and Simulation Office in the oversight of modeling and simulation related programs, and consider changes to DoD Directive 5000.59, "DoD Modeling and Simulation Management," January 4, 1994.

Management Comments. The Under Secretary concurred with the recommendation, stating that he will accomplish the recommendation within 6 months, and if changes to the directive are required, he will begin coordination on a revised version within a year.

Finding B. Synthetic Theater of War Advanced Concept Technology Demonstration

The Defense Advanced Research Projects Agency and the Joint Staff have investment plans to develop redundant joint training simulations, the STOW ACTD and JSIMS, respectively. Neither the Defense Advanced Research Projects Agency nor the Joint Staff have determined whether the two programs meet valid requirements. Establishing an overarching integrated product team to review both simulation programs can prevent redundant development, thereby better using at least $209.3 million.

Joint Training Simulations

Existing stand-alone training models and simulators are being replaced by the Military Departments with network-linked computer simulations. Those network-linked computer simulations will consist of synthetic environments and large-scale models and simulations. The Military Departments will use the network-linked computer simulations not only to conduct training for integrated and joint level staffs, but also to support all echelons of battle staff training.

The primary objective of the ACTD process is to accelerate and facilitate the application of mature advanced technologies to solve important military problems. The DoD Regulation 5000.2-R states that ACTDs are a "means of demonstrating the use of advanced mature technology to address urgent military needs." ACTDs are designed to rapidly transfer technology from developers to users. ACTDs represent an integrating effort to assemble and demonstrate a significant, new, and improved military capability that is based on mature advanced technologies. The ACTDs are not acquisition programs and are, therefore, not subject to oversight by the Defense Acquisition Board, the Joint Requirements Oversight Council, or the Major Automated Information Systems Review Council.

The Joint Requirements Oversight Council is a high-level review body, chaired by the Vice Chairman, Joint Chiefs of Staff, with membership composed of the Vice Chiefs of Staff of the Military Departments. The Joint Requirements Oversight Council is responsible for assessing military requirements for defense acquisition programs. The Joint Requirements Oversight Council identifies, evaluates, and designates potential candidates for acquisition programs. The Joint Requirements Oversight Council is also responsible for ensuring that

alternatives to any major Defense acquisition programs have been adequately considered. In addition, the Joint Requirements Oversight Council is responsible for assigning a joint priority among major programs that have met valid requirements identified by the commanders in chief, Military Departments, and others.

The United States Atlantic Command is a unified command assigned the mission of joint training for most forces based in the United States. During FY 1994, the Defense Advanced Research Projects Agency and the United States Atlantic Command began developing a joint training simulation program termed the STOW ACTD. In July 1994, the Military Departments signed a memorandum of agreement initiating the JSIMS, which is also a joint training simulation.

Similar Objectives and Developments

The stated objectives for both the STOW ACTD and the JSIMS joint training simulation acquisitions are essentially the same, that is, to create a simulated battlespace environment linked to live, virtual, and constructive simulation systems to support joint training, crisis rehearsal, doctrine development, battle planning, resource readiness, after-action review, and materiel development. Similarly, both are being developed to train the same echelons of military personnel, that is, joint or combined force commanders and battle staffs.

Synthetic Theater of War Advanced Concept Technology Demonstration. The STOW ACTD is a component of the larger Defense Advanced Research Projects Agency advanced DIS program. The stated objective for the STOW ACTD joint training simulation is to create a simulated battlespace environment linked to live, virtual, and constructive simulation systems to support joint training, crisis rehearsal, doctrine development, battle planning, resource readiness, assessment, and materiel development. The STOW ACTD would provide a capability to simulate the actions and interactions of all entities (platforms, weapons, sensors, units, etc.) through the development of synthetic forces.

The STOW ACTD will advance other underlying technologies to include synthetic forces and environments. Synthetic forces are computer-generated forces in constructive or virtual simulations that replicate the behavior of weapon systems or platforms and the behaviors of simulated command and control elements that command and control those platforms. Synthetic environments consist of terrain data bases that are used to generate a synthetic world with environmental phenomenology (rain, fog, smoke, underwater acoustics, etc.) that add realism to that world. The STOW ACTD funding of $209.3 million for FYs 1997 through 1999 is shown in Table 3.

Table 3. STOW ACTD Funding
(millions)

Source	FY 1997	FY 1998	FY 1999
STOW ACTD	$38.3	$15.5	$15.8
United States Atlantic Command	46.9	46.5	46.3
Total	**$85.2**	**$62.0**	**$62.1**

Joint Simulation System. In 1993, the Military Departments started to define a process for the shared cooperative development of a follow-on to the aggregate level simulation protocol[3] training confederation. In July 1994, the Military Departments signed a memorandum of agreement that initiated the JSIMS program. The stated objective for JSIMS was to create a simulated battlespace environment linked to live, virtual, and constructive simulation systems to support joint training, crisis rehearsal, doctrine development, battle planning, resource readiness, assessment, and materiel development. The Defense Program Guidance described JSIMS as the preeminent DoD modeling and simulation program for training. The requirements and funding for JSIMS are managed through the Joint Staff (J-7) and Joint Warfighting Center.

The JSIMS is composed of core elements of common functions, such as terrain and weather effects, and warfare functions, such as air, ground, and naval combat and logistics. The core elements (software) development will be the responsibility of the JSIMS Joint Program Office, while the warfare functions will be the responsibility of designated executive agents (land-Army, sea-Navy, and air-Air Force). The JSIMS warfare functions will provide the capability to simulate the actions and interactions of all entities (platforms, weapons, sensors, units, etc.) through the development of synthetic forces. Total JSIMS funding is about $641 million for FYs 1994 through 2003.

[3]Aggregate level simulation protocol is a computer protocol that permits the integration of distributed simulations. The protocol synchronizes the advancement of simulation time among the simulations, provides mechanisms for interaction among combat entities (direct or indirect fire engagements) across simulations, and the updates of attributes of those combat entities.

Overarching Programs

Synthetic forces and warfare functions being developed for the STOW ACTD and the JSIMS, respectively, are overarching[4] programs. The successful development and implementation of the STOW ACTD is dependent on the development and implementation of separate, overarching training simulation developments that will be linked to the STOW ACTD. Specifically, the following computer training simulation programs representing each Military Department are also elements of the STOW ACTD:

- o HeavyNet (Army),
- o Fast Fleet (Navy),
- o Air Force Semi-Automated Forces (Air Force), and
- o LeatherNet (Marine Corps).

Similarly, the successful development and implementation of the core JSIMS program depend on the development and implementation of separate overarching, training simulation developments for warfare functions that will be the responsibility of designated executive agents. Specifically, the following simulations are being developed as both stand-alone simulations and as modules that will be linked to JSIMS to provide the land, sea, air, and space representations (mission objects):

- o Warfighter's Simulation 2000 (Army),
- o Maritime Simulation (Navy), and
- o National Air and Space Model (Air Force).

We recognize that each of the respective Military Department computer training simulations is an interdependent linkage to either the STOW ACTD or JSIMS. However, it is our opinion that the relationship between the programs being developed for the STOW ACTD and the programs being developed for JSIMS is unclear.

[4]Having something in common.

Advanced Concept Technology Demonstrations

A major objective for the JSIMS program is to become the DoD computer training simulation technology standard. Therefore, we question the continuing development of the STOW ACTD. Specifically, the Defense Advanced Research Projects Agency determined that the STOW ACTD was technologically incompatible with JSIMS. In addition, STOW ACTD technologies being developed for a high-level architecture may overlap similar high-level architecture efforts under development by the Defense Modeling and Simulation Office. These and other potential redundancies might have been identified earlier if the STOW ACTD program had been classified as an acquisition program, instead of an ACTD.

Based on DoD Regulation 5000.2-R criteria, we question both the initial selection and continued classification of the STOW program as an ACTD for the following reasons.

o Neither the Defense Advanced Research Projects Agency nor the United States Atlantic Command could provide the rationale or documentary support that would demonstrate why the STOW ACTD was determined to be an "urgent military need." We believe that the readiness of the Military Departments is not contingent on the basis of computer training simulation technological developments.

o The objectives of the STOW ACTD go beyond demonstrating "advanced mature technologies." Among other things, the STOW ACTD represents an initial prototype (new development) of high-level architecture, that is, the STOW ACTD will be a means to facilitate the interoperability of all types of models and simulations among themselves and with command, control, communications, computer, and intelligence systems.

o ACTDs are designed to rapidly transfer technology from developers to users, typically within 2 to 4 years. However, when the STOW ACTD program is completed, it will have existed from FYs 1994 through 1999, a period of 6 years.

Oversight and Review

Joint Requirements Oversight Council Review. After the Defense Advanced Research Projects Agency determined that the STOW ACTD would be unable to transition technology to JSIMS, we believe that the Joint Requirements Oversight Council should have reviewed both programs to determine which

program more adequately satisfied joint training simulation technology requirements. However, at least in the area of program documentation, the JSIMS program has an approved mission needs statement and approved operational requirements document; the STOW ACTD does not.

In July 1994, the Joint Requirements Oversight Council deferred reviewing the JSIMS program because the JSIMS was not an ACAT-1 program, and instead requested an information briefing on the JSIMS program. However, we believe that the JSIMS program meets the ACAT-1 criteria in revised DoD Regulation 5000.2-R, thereby qualifying for review by the Joint Requirements Oversight Council (see Finding A).

JSIMS Program. Joint Staff officials stated that JSIMS will be the DoD training simulation technology standard and that future training simulations will be required to be technologically compatible with JSIMS. JSIMS was to be a major benefactor of the STOW ACTD program by leveraging STOW ACTD technologies, thus avoiding potentially redundant technology developments. However, the Defense Advanced Research Projects Agency initiated the Advanced Simulation Technology Thrust program[5] to meet JSIMS technology requirements because the STOW ACTD program would not be able to support JSIMS technology requirements.

STOW ACTD Program. On September 23, 1996, we met with the Assistant Director of Simulation, Defense Advanced Research Projects Agency, to discuss the latest evolution of the STOW ACTD program. The Assistant Director told us that the STOW ACTD program had been restructured to directly support the technology requirements of JSIMS. This restructuring is what created the Advanced Simulation Technology Thrust program. The FY 1997 Defense Appropriations Bill reduced Advanced Simulation Technology Thrust funding to only $3.1 million. The FY 1997 funding level undermines the ability of Advanced Simulation Technology Thrust to support the JSIMS development. The Assistant Director also briefed us on the recent draft of the STOW ACTD management plan.

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[5]The Advanced Simulation Technology Thrust program will concentrate on the four major technology risks of the JSIMS program: architecture for large-scale simulations (joint task force/major regional conflict size exercises); seamless, integrated synthetic environments; next generation, computer-generated forces; and resource reduction in the setup, operation, and after-action review of training exercises. The program's development plan has been synchronized with the JSIMS program so that technologies developed under the Advanced Simulation Technology Thrust program can transition to and have maximum impact on the design and implementation of the JSIMS program. Funding for the Advanced Simulation Technology Thrust is about $37.4 million for FYs 1997 through 1999.

Conclusion

Although the Military Departments have repeatedly acknowledged a need to improve joint training through the use of cost-effective computer training simulations, the Military Departments have historically developed the simulations independently. To remedy those problems, the DoD must ensure that adequate management oversight is exercised to prevent redundant development of computer training simulations. We believe that an Overarching Integrated Product Team[6] should be established for the purpose of reviewing both the STOW ACTD and JSIMS programs.

The scope of the review should encompass not only the core STOW ACTD and JSIMS programs, but should also consider other programs being independently developed by the Military Departments. Accordingly, the review of the STOW ACTD would also include the Army HeavyNet, the Navy Fast Fleet, the Air Force Semi-Automated Forces, and the Marine Corps LeatherNet programs. The review of the JSIMS would also include the Army WARSIM 2000, the Navy MARISIM, and the Air Force National Air and Space Model programs. By establishing the Overarching Integrated Product Team, the DoD can help ensure that the development of redundant programs is avoided and can put $209.3 million originally planned for the STOW ACTD to better use in FYs 1997 through 1999.

Management Comments on the Finding

The Under Secretary of Defense for Acquisition and Technology did not agree with the finding. The Under Secretary stated that the STOW and JSIMS are different in nature, scope, and purpose, but they are complementary. However, the Under Secretary implemented oversight that has resulted in significant program changes that address the redundancy between STOW and JSIMS. In addition, the Under Secretary did not agree with the potential monetary benefits listed in Appendix G of the draft audit report. Specifically, the Under Secretary stated that the majority of the FY 1997 STOW funds were already contractually obligated and little would be recovered if the STOW ACTD were canceled. However, we based the $209 million in potential monetary benefits on the elimination of redundant development, rather than on canceling the STOW ACTD. Accordingly, we believe that actions already initiated by the

[6]The integrated product team is composed of representatives from all appropriate functional disciplines working together with a team leader to build successful and balanced programs, to identify and resolve issues, and to make sound and timely recommendations to facilitate decisionmaking. The integrated product team focuses on strategic guidance, program assessment, and issue resolution.

Under Secretary of Defense for Acquisition and Technology to address the issues raised in the finding ensure prevention of redundant development, better using the $209 million STOW ACTD funding. The full text of the comments is in Part III. Specific comments on each recommendation are as follows:

Recommendations, Management Comments, and Audit Response

B.1. We recommend that the Assistant Secretary of Defense (Command, Control, Communications, and Intelligence) establish an overarching integrated product team to review the Synthetic Theater of War Advanced Concept Technology Demonstration and the Joint Simulation System program, to include the Army HeavyNet, the Navy Fast Fleet, the Air Force Semi-Automated Forces, the Marine Corps LeatherNet, the Army Warfighter's Simulation 2000, the Navy Maritime Simulation, and the Air Force National Air and Space Model programs to determine the relationship of the two programs to each other and to determine whether both programs are needed. If the team determines that both simulation programs are needed, develop a management plan to ensure that they complement rather than duplicate each other.

Management Comments. The Under Secretary partially concurred, stating that he agreed with the use of an overarching integrated product team to review the STOW ACTD and the JSIMS programs, to include their associated supporting programs. The Under Secretary further stated that the Executive Council for Modeling and Simulation Training has a review underway to address the issues raised in the finding.

Audit Response. We consider the Under Secretary's comments to be responsive to the recommendation. The results of the Council's review and any resultant program restructuring will be ascertained by this office in a followup inquiry, at which time the monetary benefits achieved should be more apparent.

B.2. We recommend that the Joint Requirements Oversight Council validate the requirements for the Synthetic Theater of War Advanced Concept Technology Demonstration and the Joint Simulation System program at the conclusion of the Overarching Integrated Product Team review.

Management Comments. The Under Secretary nonconcurred, stating that the Joint Requirements Oversight Council has already validated the JSIMS Operational Requirements Document. The Under Secretary further stated that the STOW does not require Joint Requirements Oversight Council validation

because it is a science and technology project that has been designated as an ACTD. Additionally, the Under Secretary stated that the Joint Requirements Oversight Council has approved the "Joint Warfighting Science and Technology Plan" of May 1996, which states that the STOW will develop and demonstrate modeling and simulation technology for major simulation development programs, such as the JSIMS. Also, the Joint Requirements Oversight Council defined and validated a set of science and technology objectives derived from the Joint Warfighting Capability Assessment process, which validates individual Defense technology objectives, including the STOW, to ensure that the U.S. technology base is capable of supporting future warfighting capabilities.

Audit Response. The audit identified specific issues relating to the lack of policy and strategy to better manage and oversee the acquisition of large-scale training simulation systems, such as the JSIMS and the STOW ACTD. Likewise, the audit showed that the JSIMS and the STOW ACTD were developing duplicative technologies. However, we believe that the planned actions outlined in the Under Secretary's response to the Finding and to Recommendation B.1. meet the intent of the recommendation, and no further comments are required.

Finding C. Effectiveness of Large-Scale Training Simulations

The Military Departments have not demonstrated the effectiveness of large-scale computer training simulations being developed. Effectiveness has not been demonstrated because requirements for performing training effectiveness evaluations, methods for accomplishing the evaluations, and the data on which to base comparisons are inadequate. As a result, DoD is investing more than $1.6 billion in large-scale computer training simulations that, if excessively relied upon for training, instead may adversely affect readiness.

Collective Unit Training Simulations

When used in a military context, computer training simulations ordinarily evoke an image of a pilot in a flight simulator learning how to fly an aircraft or of a maintenance technician seated at a desk using a computer equipped with a touch screen, learning how to repair an aircraft or tank. Although computer simulation has changed training, it does not normally evoke an image of thousands of people, some on other continents, jointly fighting a simulated battle or war. That image better fits the intention of leading-edge computer training simulations under development within the DoD.

The transformation to large-scale computer simulation has overtaken the ability of the Military Departments to evaluate the effectiveness of the simulations. The Military Departments are developing large-scale computer simulations that have not been demonstrated to be a viable alternative that will provide effective training. The primary elements needed to demonstrate effectiveness consist of new analytical methods, data bases on the effectiveness of current training, and guidance for doing effectiveness evaluations.

Training Effectiveness Evaluations. Generally, mature methodologies exist and are being competently used to evaluate the training and cost-effectiveness of individual and single crew computer training simulations. Today's leading-edge computer simulations frequently are directed at training many people, often at geographically separated locations, in command tasks instead of in the operation of a weapon or weapon system.

The shift from computer simulations designed to train an individual or single crew to large aggregations of people acting collectively calls for new tools to

evaluate large-scale training simulations. As stated in "The Development of Technology for Collective Training: Simulation Networking [SIMNET], A Case History," a study prepared by the Institute for Defense Analyses:

> Input, process, and output variables abound, but the disciplines are not yet at ease in dealing with collectives or in transforming the discrete data of individual events, person, and vehicles into meaningful, valid, and important collective measures and variables.

A New Focus on Collective Unit Training. Traditional training simulations are generally thought of as flight simulators; maintenance trainers; and more recently, computer-based instruction. The customer for those training simulations are generally the individual or weapon system crew. The effectiveness of the training simulations is gauged by their ability to teach individual or crew skills that could subsequently be transferred to actual tasks associated with a weapon platform. The training simulations are most often used for conducting individual and crew training in the Military Department schools.

Historically, collective unit training is conducted through large-scale field training exercises. Specific examples of large-scale training exercises include unit rotations at the Army National Training Center at Fort Irwin, California; the Marine Corp Air Ground Combat Center at Twentynine Palms, California; the Air Force Red Flag exercises at Nellis Air Force Base, Nevada; and Navy fleet exercises. This type of collective training has established a reputation for effectiveness within the Military Departments through long use and evolutionary improvement.

Because of significant advances in computer technology, large-scale computer training simulations are now part of traditional training exercises. The customers for these new computer simulations include the commanders and battle staffs of battalions, brigades, and divisions through an operational continuum to support Army, joint, and coalition force training across the globe. Large-scale computer training simulations represent the leading edge of technology and represent a significant shift in who is being trained and in the skills being trained. Large-scale computer training simulations can involve literally thousands of personnel who are physically located on several continents and who are linked for the purpose of conducting a simultaneous combination of live, virtual, or constructive training simulations.

The collective unit field training exercises are the benchmark against which large-scale computer training simulations can and should be analyzed. Whether large-scale computer training simulations are preferable to live exercises can be determined in part by comparing the training results from large-scale computer training simulations to the training results from live exercises.

Effectiveness of Large-Scale Computer Training Simulations

A cost-effectiveness analysis is the means by which alternative solutions are analyzed. This analysis should consider both the cost and effectiveness of the proposed computer training simulation and should provide the justification for selection of the preferred solution.

The Military Departments have not demonstrated that large-scale computer training simulations being developed will be as effective as current training methods. In some instances, the Military Departments perform an analysis of alternatives as required by DoD 5000.1, but the analyses do not justify the requirement for the simulation. The most persuasive rationale for supporting the decision to develop a simulation would be confirmation that the proposed simulation will provide more effective training or at least the same level of training effectiveness at an equal or lesser cost than the current training method.

Training Effectiveness

SIMNET Training Effectiveness. The Army either has performed or has tasked others to perform multiple studies on the effectiveness of SIMNET. However, what those studies demonstrate in terms of the effectiveness of SIMNET is not clear. A study performed by the Army Research Institute for the Behavioral and Social Sciences, undertaken to provide information on how to plan evaluations for the CCTT, reviewed several SIMNET evaluations and concluded that the evaluations "yielded results that permit no valid inferences about transfer of SIMNET training to soldiers' performance in field settings." The training effectiveness of SIMNET is still questionable, even though it has been in use for several years. Besides problems in determining the effectiveness of the predecessor system, the Army lacks systematic data on its live training against which to compare the CCTT or at least to set effectiveness standards for CCTT.

CCTT Training Effectiveness. The Army performed a cost and training effectiveness analysis (current Army terminology is Training Effectiveness Analysis) for its CCTT. The Army CCTT program is an evolutionary extension of the SIMNET initiated by the Defense Advanced Research Projects Agency. The SIMNET is the prototype for large-scale computer training simulation systems within DoD. The training effectiveness portion of the analysis of CCTT was based on SIMNET and concluded that the effectiveness of SIMNET had not been demonstrated. Nevertheless, the Army proceeded to develop CCTT, even though convincing data did not exist on training effectiveness and cost-effectiveness for both Army "live training" and SIMNET. The CCTT training effectiveness analysis concluded that the CCTT had the potential to be an effective simulation. The basis for this conclusion was that CCTT will improve on the features and capability of SIMNET to provide even more effective training--even though the effectiveness of SIMNET had not been demonstrated.

Cost-Effectiveness

CCTT Cost-Effectiveness. The remainder of the CCTT analysis was concerned with the potential Operating Tempo (OPTEMPO)[7] savings if CCTT was developed. The cost-effectiveness analysis concluded that the monetary benefits of developing the CCTT would pay back the life-cycle costs within the estimated 15-year service life of CCTT. We believe this conclusion is flawed for at least three reasons.

o First, the primary value that must be satisfied is equal or greater training effectiveness by the use of CCTT after OPTEMPO reductions. The CCTT analysis did not demonstrate that the CCTT had the potential to be more effective than either live training or SIMNET.

o Second, the monetary benefits were projected from an operational baseline that the Army is not funding at the installation level. For example, the baseline of 800 tank miles per year is higher than actual current funding.

o Third, we believe that a service life of 15 years for CCTT, especially without significant modification, is excessive because the weapon systems on which CCTT is based would then be in service for more than 35 years.

The personnel being trained are the ultimate users for CCTT or any other large-scale computer training simulation. While at the National Training Center, we discussed both live training and training simulations with the ultimate users. Regarding the training efficacy of large-scale computer training simulations, such as the CCTT, the users were concerned about substituting large-scale computer training simulations for live exercises. The users placed significant value on computer training simulations as an enhancement for individual and crew training (for example, a tank crew), but were skeptical of attempts to substitute large-scale computer simulations for live training.

JSIMS Cost-Effectiveness. The Military Departments and the Joint Staff have not demonstrated the need for and cost-effectiveness of JSIMS. The mission need statement for JSIMS suggests that the program was developed in response to DoD Planning Guidance for FYs 1995 through 1999. Among the purposes for future simulations set forth in that guidance were requirements to support joint (elements of more than one Military Department) and combined (elements of two or more allied nations) exercises, increase use of simulators, integrate simulations and field exercises, and use advances in simulation to reduce requirements for field training. The mission need statement further states, "All aspects of preparing for war can be improved through the use of computer simulation."

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[7]OPTEMPO is the amount of mission performance operations and live training that each Military Department budgets to conduct each year. OPTEMPO is expressed in terms of the average number of flying hours per aircraft, steaming days per ship, or miles traveled per vehicle.

Although the JSIMS operational requirements document contains ambiguous statements that imply that some savings might result from developing JSIMS, we could not identify a formal cost-effectiveness analysis of JSIMS. The JSIMS operational requirements document states that existing Military Department simulations require high staffing levels for Military Department and joint exercises. The document goes on to say that it would be expensive to enhance existing models and " . . . it may no longer be cost-effective to update models to support evolving joint and Military Department training requirements."

The JSIMS Concept of Operations, dated January 29, 1996, briefly addressed the future evaluation of JSIMS, stating that the Joint Program Office is responsible for verifying that the JSIMS Synthetic Environment "runs as advertised." The Concept of Operations further states that the ultimate users will be responsible for accrediting that the JSIMS Synthetic Environment is useful for their particular application. Although total funding for JSIMS had not yet been finalized as of July 1, 1996, preliminary indications are that when all the constituent elements are considered, JSIMS will cost $641 million.

WARSIM 2000 Cost-Effectiveness. The WARSIM 2000 is the Army element that will eventually link to the overall JSIMS program. The WARSIM 2000 will use a computer-based simulation and associated hardware to support the training of unit commanders and their battle staffs, from battalion through theater level, and to support training events in educational institutions. The cost and training effectiveness analysis for WARSIM 2000 is based on four questionable assumptions.

- o Simulation can enhance headquarters and command post training from battalion through theater level.

- o The requirement to use simulation to train the unit commanders and battle staffs from battalion through echelons above the corps level will continue.

- o Previously completed cost analyses that have not been updated are still relevant.

- o The service life of WARSIM 2000 is 20 years.

The reason why these assumptions are questionable is that the Army has not demonstrated that replacing existing training simulations at the battalion level and higher echelons with numerous interacting "micro" simulations results in improved training. Contrarily, empirical and theoretical evidence shows that this approach produces worse results instead of better results. The Army Training and Doctrine Command estimates funding requirements to develop WARSIM 2000 at $172 million through FY 2003.

Fire Support Combined Arms Tactical Trainer Cost-Effectiveness. The Army began developing the Fire Support Combined Arms Tactical Trainer (FSCATT) based on a "critical" need to provide a realistic method of training the field artillery gunnery team to deliver accurate and predicted fires in an integrated, closed-loop manner. The U.S. Army Training Support Center "Training Development Study for the FSCATT" was based on the assumption

that reduced training resources and higher ammunition costs prohibit firing sufficient quantities of ammunition to attain and sustain the required level of proficiency needed by the field artillery gunnery team.

The cost-effectiveness segment of the "Training Development Study for the FSCATT" derives cost savings from assumed reductions in the quantity of ammunition fired and from reduced OPTEMPO. Because these assumptions regarding cost-effectiveness can only be achieved through a reduced level of field training, the "Training Development Study for the FSCATT" makes the contradictory statement that:

> Incorporation of . . . (FSCATT) into the current training strategy is not specifically designed to replace field training, but rather augment and enhance training while allowing the unit to train at the same or better levels of proficiency which will greatly enhance efficiency.

The "Training Development Study for the FSCATT" concluded that:

> The actual training effectiveness of . . . (FSCATT) will not be known until the system is built and then tested. However, based on reviews of similar and predecessor simulators, the requirements specified in the Operational Requirements Document and the gunnery task list, subject matter experts input, and survey results, the analysis indicates that CLASS (now FSCATT) has the potential to train gunnery tasks to standard.

The similar and predecessor simulator referred to in the "Training Development Study for the FSCATT" is the CCTT. As indicated in our discussion on the CCTT, the training effectiveness of the CCTT was predicated on being able to improve on the features and capability of SIMNET. This training effectiveness assumption was made even though the effectiveness of SIMNET could not be demonstrated. Therefore, the "Training Development Study for the FSCATT" based training effectiveness conclusions on subject matter experts and on the training effectiveness of CCTT, for which the Army has not demonstrated training effectiveness. The Army Training and Doctrine Command estimates funding requirements to develop FSCATT Phase 1 at $122 million through FY 2003.

Operating Tempo Reductions

At present, DoD lacks substantive research and evaluations that would justify OPTEMPO tradeoffs that could be achieved through large-scale computer training simulations. In addition, computer training simulations to train the forces above the crew level have not established OPTEMPO tradeoffs or illustrated a current existing deficiency in high level training.

Questionable Analysis of Benefits. Cost-effectiveness justifications for making significant investments in large-scale training simulations universally refer to tradeoffs and payback periods associated with reductions in OPTEMPO,

reductions in flight hours, or a reduction in steaming hours or days. However, when we analyzed those cost-effectiveness tradeoffs, we determined that potential benefits from investments in large-scale training simulations will not be realized.

We examined several Army sponsored training simulations and performed a discounted cash flow analysis on monetary benefits to be achieved through reductions in vehicle miles driven and in ammunition costs. Specifically, for the CCTT, our analysis indicated that at a discounted rate of 7 percent, using data supplied by the Army Training and Doctrine Command, the CCTT would not break even by the year 2030. At that point, the CCTT would become technologically obsolete. Similarly, we determined the same conclusions for WARSIM 2000 and the FSCATT. Appendix E shows our calculations of the payback periods for the CCTT, WARSIM 2000, and FSCATT. Specifically, for the CCTT, WARSIM, and FSCATT programs, our calculations showed that after considering OPTEMPO reductions provided to us by the Army Training and Doctrine Command for each of the simulations, the programs would not achieve break even by the year 2030, and would, in fact, increase costs by about $818 million over that same time period.

In addition, the Army Training and Doctrine Command analysis used a baseline of 800 miles per tank per year and estimated OPTEMPO reductions from that baseline. For the CCTT, the analysis proposed reducing OPTEMPO miles by 59.64 miles for tanks and by 60 miles for other mechanized vehicles. In a further analysis that we did (see Appendix F) using a discounted rate of 7 percent, and again using data supplied by Army Training and Doctrine Command, we determined that OPTEMPO vehicle miles would have to be reduced by about 199.4 miles for tanks and by 200.6 miles for mechanized vehicles in order for CCTT to achieve a breakeven position over its estimated useful life of 15 years.

However, the actual miles of operational funding at the unit level is significantly less than 800 miles per tank per year. The Army analysis is unclear as to whether the anticipated reductions can be made from a lower baseline. For example, at Fort Riley, the miles funded for FY 1996 were less than 600 miles per tank per fiscal year. In order for CCTT to reach a breakeven position over its estimated useful life of 15 years, the actual funded OPTEMPO vehicle miles would have to be reduced to a level of about 400 miles per vehicle per year to generate sufficient "out of pocket" OPTEMPO savings at the unit level through the use of CCTT.

Different Perspectives on the Benefits of OPTEMPO Tradeoffs. Other major commands disagree with the Army Training and Doctrine Command in establishing OPTEMPO tradeoffs. Specifically, Forces Command and the Army Training and Doctrine Command do not agree with OPTEMPO tradeoffs. The Forces Command does not support OPTEMPO tradeoffs before fielding a system. For example, the Army Unit Conduct of Fire Training OPTEMPO tradeoffs had to be modified after the system was fielded because the original estimates could not be realized. Both Forces Command and operational personnel stated that a training device, simulator, or computer simulation is an enhancement to the weapon system and is never a replacement for training with

the weapon system. Army operational personnel, the ultimate customers for any training simulation, were unanimous in stating that they are not willing to trade off bullets or tank miles for a training simulator.

Lack of Data for Benefits Analysis. Proposed OPTEMPO tradeoffs are made on judgment calls because no justification or documentation exists to support the OPTEMPO tradeoffs that were used as justifications for developing large-scale computer simulations. Also, the Forces Command believes that some of the ammunition tradeoffs in the OPTEMPO could cause an unacceptable risk to combat readiness and that "proven training transfer," or transfer of training that has been proven reliable, needs to be validated before tradeoffs in OPTEMPO are made. In addition, Forces Command officials stated that computer simulations need to be distributed in a timely manner and in sufficient quantities to train the total force.

Technology Driven Development

The scarcity of data on the effectiveness of today's live training makes the evaluation of the cost-effectiveness of proposed simulations difficult. For example, the Army is a leader in developing large-scale training simulations, but the Army lacks a data base that documents the effectiveness of the live training done at the National Training Center. Without a data base on the effectiveness of live training effectiveness, it is difficult to demonstrate that a training simulation is a cost-effective substitute for existing training methods.

Lack of data is not the only reason for failing to adequately analyze the alternatives when proposing large-scale computer simulations. The Army Research Institute study performed on the CCTT concluded that analytical evaluations would be more effective than empirical evaluations. However, other studies reached an opposite conclusion.

We identified several Army justifications for developing large-scale computer training simulations:

- the availability of modern technology with which to develop large-scale computer training simulations;
- decreasing resources for live training, environmental restrictions, and safety considerations;
- political constraints in allied countries; and
- large-scale computer training simulations are being presented as the only efficient means of providing joint training (training that is not presently being done) at the command and staff level.

The Army used these reasons to support the conclusion that technology in the form of training simulations would be the solution to training problems.

The Military Departments have not demonstrated that large-scale computer simulation is a cost-effective solution. The stated needs for the systems, reduced OPTEMPO cost, less environmental damage, and joint training have merit, but the merit is conditional on the training effectiveness of the systems. The goal of reducing training costs in a budget-constrained environment is unarguable, but reducing costs while not demonstrating that the solution is effective does not support continued development of the large-scale training simulations. Both training effectiveness and cost-effectiveness must be demonstrated in justifying and developing large-scale computer training simulations.

Training and Financial Risks

Two major categories of risk manifest themselves as the Military Departments move forward with the development and use of large-scale computer training simulations. The most critical risk from a military perspective is degraded training or readiness risk; the other risk is imprudent use of scarce training dollars.

Readiness Risk. The Military Departments disagree as to what the cost-effectiveness expectation is for computer training simulations. One argument offered is that the objective should be training of equal effectiveness at less cost, whereas the Institute of Defense Analysis report stated that the standard should be better training at the same or lesser cost. Irrespective of which standard is used, the minimum result should be at least equal training when the DoD invests in large-scale computer training simulations. The Military Departments have not answered the question as to whether the simulations will provide at least equal training.

There are at least two reasons why. The first is that DoD does not always ask whether simulations will provide equal training. The second is that the Military Department analysis of the alternatives starts with the assumption that the large-scale computer simulation will be effective and never waiver from that assumption.

The Military Departments risk degraded training and readiness when they do not or cannot evaluate the effectiveness of large-scale computer training simulations, especially the types of computer training simulations under development. Unless new methods of training are demonstrated to be at least as effective as current methods, the risk is a decrease in readiness--visible or invisible. Even if the evaluation of effectiveness cannot be competently done until a system is at or near completion, the evaluation must be done to ensure that training results have not been degraded. Unfortunately, by that time, the funds will have been spent, leading to financial risk.

Financial Risk. As the defense budget shrinks, the Military Departments are committing more of their limited resources to large-scale computer training simulations by reallocating dollars from other training programs. Those

reallocations along with the development of simulations agreeing to OPTEMPO reductions risk future unfunded training programs if the computer training simulation is not an effective substitute for current live training.

Conclusion

Although limited data exist to confirm the effectiveness of combined arms exercises, field training exercises, and live-fire training exercises, those training methods have been validated by use over an extended period and are generally accepted as effective. In contrast, the Military Departments have not demonstrated the effectiveness of large-scale computer simulations for field-training exercises in terms of the training mission and cost-effectiveness. Accordingly, the burden of demonstrating the effectiveness of large-scale computer training simulations rests with the Military Departments developing them.

We believe that the Military Departments are making a significant investment in a technology for its own sake. They have not defined a requirement for the simulations, and they have yet to demonstrate the efficacy of the simulations. Further, to determine the cost-effectiveness of the simulations, the Military Departments need to develop methods of analysis.

DoD is concerned about the limitations in the capability to properly evaluate training effectiveness for the new systems. In studies sponsored by the Under Secretary of Defense for Personnel and Readiness, the key weaknesses identified were:

- the lack of validated data on the systems being simulated and
- the lack of standard methodology for documenting the effectiveness of training systems.

However, DoD must match that concern with resources and actions to fix the problems.

Recommendations, Management Comments, and Audit Response

C. We recommend that the Under Secretary of Defense for Personnel and Readiness:

1. Establish policy and procedures for evaluating the training effectiveness and cost-effectiveness of large-scale training simulations. Policy and procedures should include:

o benchmarks against which to measure the benefits of large-scale training simulations and

o the plans, methods, and techniques to gather data on live exercises to establish a data base of training results.

Management Comments. The Under Secretary concurred, stating that advanced training simulations can give forces a key operational edge by directly supporting real-world operations and by providing the right training, in the right quantities, at the right pace, from geographically-dispersed locations. The Under Secretary agreed that the Department should seek more formal analyses of the training effectiveness and cost-effectiveness of large training simulation acquisitions. Additionally, the Deputy Under Secretary of Defense (Readiness) is committed to developing policy and guidelines for conducting cost-effectiveness analyses of large-scale training simulations that allow analysts to select the best method under the circumstances, describe the procedures for the various methods, and provide examples that may be used as models to emulate. Also, the Under Secretary of Defense for Personnel and Readiness will establish a historical training effectiveness data base and will ensure appropriate access to the data base. The Under Secretary of Defense for Personnel and Readiness will also investigate the potential to incorporate such plans and assessments in the Chairman of the Joint Chiefs of Staff Joint Training Plan.

2. Direct the Military Departments to perform a training effectiveness evaluation for all Acquisition Category 1A programs before each milestone approval.

Management Comments. The Under Secretary concurred, stating that he has already designated the programs as "Special Interest," and as such, they are not designated ACAT-1A. The Under Secretary will proceed with the recommendation as soon as the requisite guidelines and policies are in place.

Finding D. Successful Efforts in Developing and Acquiring Training Simulations and Devices

The Army and the Navy successfully cooperated in the development and acquisition of training devices, simulators, and simulations. The Army and Navy have collocated the organizations responsible for developing and acquiring training devices, simulators, and simulations in Orlando, Florida. Those efforts have resulted in a high degree of technological synergy through the leveraging of resources.

Common Support Function

Intra-Service Support Agreement. In March 1950, the Army Special Devices Center (subsequently renamed Simulation, Training, and Instrumentation Command [STRICOM]) and the Navy Special Devices Center (subsequently renamed Naval Air Warfare Center Training Systems Division [NAWCTSD]) entered into an intra-Service support agreement that continues to have a positive effect on the acquisition of computer training simulations. The initial agreement called for the Army to participate in the evaluation, research, development, and procurement of training aids and devices. The Navy agreed to provide office space, office equipment, and facilities. Since the initial intra-Service support agreement, the business relationship between the two organizations has matured to become a model of Army and Navy cooperation. Located at the Central Florida Research Park, Orlando, Florida, the functional organization supports Army and Navy efforts in the development and acquisition of training simulations and devices. The mission and function of each organization are described below.

Simulation, Training, and Instrumentation Command. The mission and function of STRICOM is to provide acquisition management of training devices, simulations, simulators, instrumentation, threat simulators, and targets. The STRICOM also serves as the DoD focal point for the distributed, interactive simulation environment and as the DoD Executive Agent for aggregate level simulation protocol. In addition to providing effective training systems to the soldier, STRICOM also provides quality life-cycle support for fielded products.

Naval Air Warfare Center Training Systems Division. The mission and function of NAWCTSD is to plan and perform a full range of directed research

and development in support of naval training systems for all warfare areas and platforms. The NAWCTSD also maintains an expanding technology base and transitions research results to the fleet.

Intra-Service Cooperation

The STRICOM and NAWCTSD routinely support each other's training simulation acquisitions and share resources and expertise through an integrated, business-based arrangement. For example, the NAWCTSD provides intra-Service support to STRICOM in the following areas.

Research and Engineering. The Research and Engineering Division provides a wide spectrum of technical support to STRICOM. Technical support includes the areas of project engineering, systems engineering, software engineering, safety engineering, environmental, and visual engineering. This cross-fertilization of technical skills and experience contributes greatly to the sharing of technical support between the organizations.

Logistics Division. The STRICOM acquires logistic support in the areas of training system facilities, site preparation, and electronic interference measurements. The Logistics Division also provides expertise and experience in contract operation and maintenance support.

Contracts Division. The Contracts Division provides a wide variety of functions that serve customers at all levels. The division is responsible for "cradle to grave" contracting services for training simulation acquisitions. The NAWCTSD provides contracting and small purchase support to STRICOM for acquiring training aids and devices, simulators, and simulations. The diverse experience gained through this working relationship allows for state-of-the-art technologies and lessons learned to be exchanged between the two organizations.

Corporate Operations Division. The Corporate Operations Division acts as a service and support organization providing the following services: strategic management support, information management, human resources, security, public affairs, financial management, and counseling. As a result, STRICOM has significantly reduced the Army staffing of support requirements.

Collocated Organizations

Contributing to the joint nature of operations between the STRICOM and NAWCTSD organizations is the University of Central Florida Institute for Simulation and Training (the Institute), located within the Central Florida Research Park adjacent to the STRICOM and NAWCTSD organizations.

University of Central Florida Institute for Simulation and Training. The Institute acts as a resource center for organizations involved in simulation and training research and development. The Institute works jointly with the Military Departments, industry, and other academic institutions to develop simulation technologies. The STRICOM and NAWCTSD organizations are able to expedite technology transfers and joint research projects. Additionally, because of its proximity to STRICOM and NAWCTSD and the mutual relationship established between those organizations, state-of-the-art technology is incorporated into Army and Navy training simulations.

Air Force Orlando Operating Location. The Air Force Orlando Operating Location is essentially a liaison activity and does not mirror the functions of STRICOM and NAWCTSD organizations. The Air Force presence at the Orlando site is composed of an integrated team formed from two other Air Force locations, the Training Systems Product Group at Wright-Patterson Air Force Base, Ohio, and the Aircrew Training Research Division, Phillips Laboratory, Mesa, Arizona.

In June 1996, the Air Force Agency for Modeling and Simulation was established at the Orlando Operating Location. The agency's mission is to implement Air Force, joint, and DoD modeling and simulation policy and standards. The agency will be staffed by 18 military personnel and 15 civilians. The Air Force decision to collocate the agency in Orlando was made to take full advantage of the opportunity to leverage and coordinate Air Force modeling and simulation efforts with the other Military Departments and Defense agencies.

Conclusion

In summary, the Army STRICOM and Navy NAWCTSD training simulation organizations represent the successful consolidation of a common support function. The coordination between those organizations and the teams from the university and industry in the same location result in technological synergy that benefits the DoD in the development of training simulations and devices. We attribute much of the success of STRICOM and NAWCTSD to the expertise, professionalism, and spirit of cooperation exhibited by their personnel.

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Part II - Additional Information

Appendix A. Audit Process

Scope and Methodology

We reviewed the acquisition process for computer training simulations. Appendix D lists the computer training simulations reviewed. We reviewed requirements documents, obtained related cost data for selected computer training simulations, and analyzed the corresponding Army, Navy, Air Force, and DoD regulations. We examined available justifications for large-scale computer training simulations to determine whether requirements for them existed. We also analyzed the justifications to determine whether cost-effectiveness evaluations had been performed and whether the justifications supported conclusions concerning anticipated training effectiveness. We interviewed officials involved with training simulation and device acquisitions. We also interviewed Navy and Air Force aircrews to determine the effectiveness of simulation training and toured Army, Navy, and Air Force simulation and combat training centers.

Audit Period and Standards. We performed this economy and efficiency audit from September 1995 through June 1996 in accordance with auditing standards issued by the Comptroller General of the United States, as implemented by the Inspector General, DoD. Accordingly, we included such tests of management controls as we considered necessary. We did not rely on computer-processed data or statistical sampling procedures to perform the audit.

Contacts During the Audit. We visited or contacted individuals and organizations within the DoD. Further details are available on request.

Management Control Program

DoD Directive 5010.38, "Internal Management Control Program," April 14, 1987,* requires DoD managers to implement a comprehensive system of management controls that provides reasonable assurance that programs are operating as intended and to evaluate the adequacy of those controls.

Scope of Review of the Management Control Program. We limited our review because of relevant coverage in Inspector General, DoD, Report No. 96-028, "Implementation of the DoD Management Control Program for

*DoD Directive 5010.38 has been revised as "Management Control (MC) Program," August 26, 1996. The audit was performed under the April 1987 version of the Directive.

Major Defense Acquisition Programs," November 28, 1995. The report discusses the effectiveness of the management control program that the Defense Acquisition Executive and the Component Acquisition Executives used for major Defense acquisition programs. The report concludes that the acquisition community had not effectively integrated DoD Management Control Program requirements into its management assessment and reporting processes. As a result of the report recommendations, the Under Secretary of Defense for Acquisition and Technology integrated DoD Directive 5010.38 requirements into the March 15, 1996, revision to DoD Directive 5000.1, "Defense Acquisition," and DoD Regulation 5000.2-R, "Mandatory Procedures for Major Defense Acquisition Programs (MDAPs) and Major Automated Information System (MAIS) Acquisition Programs," March 15, 1996. Acquisition managers are now to use program cost, schedule, and performance parameters as control objectives to implement the DoD Directive 5010.38 requirements. The managers are to identify material weaknesses through deviations from approved acquisition program baselines and exit criteria in the "Defense Acquisition Executive Summary" report. Accordingly, we limited our review to management controls related to the acquisition of large-scale training simulations, simulators, and devices. We reviewed the adequacy of management's self-evaluation applicable to those controls.

Adequacy of the Management Control Program. We identified material management control weaknesses, as defined by DoD Directive 5010.38, in that DoD did not determine oversight responsibilities for training simulation acquisitions, establish procedures to prevent redundant developments of training simulation acquisitions, or establish procedures for determining the effectiveness of training simulations. Recommendations A.1., B.2., C.1., and C.2., if implemented, will correct the weaknesses. A copy of the final report will be provided to the senior official responsible for management controls within the Office of the Secretary of Defense.

Adequacy of the Management's Self-Evaluation. Management's self-evaluation was not adequate to detect and report the material management control weaknesses identified by the audit because training simulation acquisitions were considered as part of a weapon system acquisition or an advanced concept technology demonstration. Accordingly, management identified training simulation acquisitions as low risk and, therefore, did not evaluate them.

Appendix B. Summary of Prior Audits and Other Reviews

During the last 5 years, the General Accounting Office (GAO); the Inspector General, DoD; the Army Audit Agency; and the Air Force Audit Agency issued reports that specifically discuss computer training simulations.

General Accounting Office

GAO Report No. GAO/NSIAD 96-44 (OSD Case No. 9997), "Cost-Effective Development of Simulations Presents Significant Challenges," November 1995, concluded that the Joint Simulation System (JSIMS) progressed beyond the conceptual stage since a memorandum of agreement was signed in June 1994. Additionally, the Military Departments could duplicate costs by unnecessarily building simulation capabilities that JSIMS will already include. The report recommended that the Office of the Secretary of Defense establish a joint funding line for the core development of JSIMS and direct the Secretaries of the Army, the Navy, and the Air Force to establish funding lines for their respective executive agent JSIMS responsibilities. The report also recommended that the Under Secretary of Defense for Acquisition and Technology assume a stronger management role to resolve simulation issues by defining JSIMS, developing a definitive plan of action, and developing a transition strategy to phase out aggregate level simulation protocol. The DoD generally agreed with the audit results and recommendations.

GAO Report No. GAO/NSIAD 93-211 (OSD Case No. 9436), "Commanders Lack Guidance and Training for Effective Use of Simulations," August 1993, states that while the Army developed a training strategy to incorporate the use of simulations, the strategy would not provide unit commanders the detailed guidance they needed to make the most effective use of simulations. Specifically, the guidance did not link simulations with the wartime tasks that units could expect to perform. In addition, the Army's professional development courses did not contain sufficient information on the availability and applicability of simulations. The report recommended that the Secretary of the Army direct the Army Training and Doctrine Command to modify the Combined Arms Training Strategy or develop an alternative means to link simulations with specific wartime tasks and to modify its professional development curricula to include instruction on the use of simulations, their linkage with specific wartime tasks, and techniques to incorporate those simulations into unit training plans. The DoD generally agreed with the audit results, but disagreed with one of the two recommendations, stating that the Combined Arms Training Strategy purposely did not link specific simulations to specific wartime tasks and was intended to be descriptive rather than prescriptive. The DoD agreed with the recommendation for modifying the Army's professional development curricula.

GAO Report No. GAO/NSIAD 93-122 (OSD Case No. 9319), "Management Framework Improved, but Challenges Remain," May 1993, states that while the Defense Modeling and Simulation Office made progress in working to enhance DoD simulation capabilities, its future was clouded by a lack of permanent staff. The report further states that the Army was uncertain about the most cost-effective combination and quantity of Combined Arms Tactical Training systems needed or the extent to which they would be linked together to train higher echelons. Plans for the Close Combat Tactical Trainer and other Combined Arms Tactical Training systems initially focused on integrating simulations and field training at the battalion level. However, Army officials planned to use the Close Combat Tactical Trainer at the platoon and company level. The report recommended that the Office of the Secretary of Defense properly staff the Defense Modeling and Simulation Office to carry out its assigned responsibilities and eliminate overlap between the two Joint Staff directorates by clearly delineating each directorate's roles and responsibilities in the simulation area. The DoD concurred with the majority of the audit results and recommendations on the Defense Modeling and Simulation Office and the Close Combat Tactical Trainer program. However, concerning the recommendation to eliminate duplicative responsibilities within the two directorates of the Joint Staff, DoD stated that several joint staff directorates share modeling and simulation responsibilities, not just the directorates cited in the report. The DoD stated that the shared responsibility does not constitute unneeded duplication of effort.

Inspector General, DoD

Inspector General, DoD, Report No. 93-060, "Duplication/Proliferation of Weapon Systems' Modeling and Simulation Efforts Within DoD," March 1, 1993, states that DoD is procuring and developing modeling and simulation projects without adequate coordination and control. The report recommends that the Under Secretary of Defense for Acquisition (now the Under Secretary of Defense for Acquisition and Technology) develop policies and responsibilities related to investment, internal development, interoperability standards, modification of existing assets, and maintenance of catalogues. The Under Secretary of Defense for Acquisition concurred with all recommendations and took the recommended actions.

Inspector General, DoD, Report No. 92-125, "DoD Management of Electronic Warfare Threat Simulators for Training," July 15, 1992, states that the Air Force Tactical Air Command lacks required electronic warfare threat simulator assets and that the Military Departments are risking unnecessary duplication by developing separate electronic warfare threat simulators for training. Also, the fire-suppression contract at the Dare County Bombing Range, North Carolina, is not cost-effective. The report recommends consolidating all funding for testing and training into an Office of the Secretary of Defense program element and requiring that the Military Departments get written concept approval for threat simulator projects with a value of $5 million or more before requested projects and funding are entered into the Program

Objective Memorandum or budget. Both the Air Force and Director, Test Systems Engineering and Evaluation, partially concurred with the report and described planned or completed actions that should correct the identified deficiencies.

Inspector General, DoD, Report No. 92-002, "Operation and Modification of Flight Simulator Training Devices," October 9, 1991, states that flight simulators and their parent aircraft were not being modified concurrently as required because of late identification of needed modifications and uneven funding of training systems covering the parent aircraft. Also, the Military Departments were not evaluating the effectiveness of training. The report made no recommendations because the Military Departments acknowledged awareness of the problems.

Inspector General, DoD, Report No. 91-063, "Use of the Baseline Concept in Managing Major Weapon System Acquisitions," March 18, 1991, states that training requirements were not being included in the baselines for major weapon systems. The report recommends that the Under Secretary of Defense for Acquisition (now the Under Secretary of Defense for Acquisition and Technology) establish a requirement in the new DoD Manual 5000.2-M, "Defense Acquisition Management Documentation and Reports," February 21, 1991, for program managers to establish milestones for initial training and initial provisioning in the quarterly "Defense Acquisition Executive Summary" reports for major weapon system programs in the production phase of acquisition. The Director, Acquisition Policy and Program Integration Office, of the Under Secretary's office, concurred with the recommendation and stated that the draft DoD Manual 5000.2-M includes more definitive language regarding the inclusion of training and provisioning intermediate milestones in the Defense Acquisition Executive Summary reports for major weapon system programs.

U.S. Army Audit Agency

U.S. Army Audit Agency Report No. 91-A1, "Development of Computer-Based Models and Simulations," July 1991, states that the auditors prepared an advisory report with suggested actions and management checklists to assist managers and model and simulation developers. The Deputy Under Secretary of the Army (Operations Research) endorsed the advisory report, stating, "The advisory report furnishes a sound basis for managing model and simulation development by all levels of management." The report concluded that the Army needed policies and procedures to ensure that models and simulations were properly managed, justified, approved, and controlled. Specific recommended actions included requiring new model and simulation development efforts to conform to DoD and Department of the Army documentation standards, requiring proper verification and validation efforts to be documented before new models and simulations are accredited for use in Army applications, and requiring revalidation of models and simulations each time changes are made.

Air Force Audit Agency

Air Force Audit Agency Project 95064034, "Simulators for Mature Weapon Systems," August 15, 1996, states that critical aspects of Air Force simulator management for mature weapon systems were not effective. Specifically, Air Force personnel did not efficiently manage simulator modification planning and budgeting processes. In addition, Training Systems Product Group personnel located at Ogden Air Logistics Center and Aeronautical Systems Center did not properly use Air Force funds for the C-130 Aircrew Training System nor effectively manage C-141 Aircrew Training System organizational issues. The Air Force Audit Agency recommended that Headquarters, Air Force Materiel Command, assess simulator capabilities, initiate requirements documents, and program funds within the biennial planning, programming, and budgeting system; quantify the potential cost savings and training benefits associated with simulator concurrency, and include them in the corresponding requirements document; use system training plans to define simulator-unique requirements and milestones; and use the Aircrew Training Technical Planning Integrated Product Team to plan for Air Force-wide simulator deficiencies and to address corresponding modernization issues. The report also recommended that the Headquarters, Air Force Materiel Command Contracting Directorate, should require Systems Program Office and Training Systems Product Group contracting personnel to include an associate contractor requirement in aircraft and simulator contracts when data exchange is anticipated and enforce associate contractor requirements. Additionally, the report recommended that the Air Force Deputy Chief of Staff (Plans and Operations) should establish an Air Staff-level focal point for simulator-unique budget issues and establish a process for Training Systems Product Group personnel to retain control over budget input and execution for simulator-unique modification funds. Management officials generally agreed with the audit results and recommendations.

Appendix C. Glossary of Technical Terms

Advanced Distributed Simulation. Advanced distributed simulation applies a common core of advanced technologies (including computer, display, communication, and simulation) to provide a mix of live, constructive, and virtual simulation methods across the spectrum of DoD uses, from training and readiness through requirements generation, prototyping, and fielding. The advanced distributed simulation and the distributed interactive simulation are synonymous.

Aggregate Level Simulation Protocol. The aggregate level simulation protocol permits the integration of distributed simulations. The protocol synchronizes the advancement of simulations, provides mechanisms for interaction among combat entities (direct or indirect fire engagements) across simulations, and provides the update of state attributes of those combat entities.

Architecture. Architecture is the high-level organization of hardware or software systems.

Automated Information System. The automated information system is a combination of computer hardware and software, data, telecommunications, or all of three, that performs functions such as collecting, processing, storing, transmitting, and displaying information. Excluded are computer resources, both hardware and software, that are:

- o physically part of, dedicated to, or essential in real time to the mission performance of weapon systems;
- o used for weapon system specialized computer training simulation, diagnostic test and maintenance, or calibration;
- o or used for research and development of weapon systems.

Battlespace. Battlespace refers to the physical environment in which the simulated warfare will take place and to the forces that will conduct the simulated warfare. All elements that support the front line forces (logistics and intelligence) are included in this definition of battlespace.

Benchmark. A benchmark is the activity of comparing the results of a model or simulation with an accepted representation of the process being modeled.

Classes of simulation are as follows:

- o **Live Simulation.** Live simulation is a simulation involving real people operating real systems.

o **Virtual Simulation.** A virtual simulation involves real people operating simulated systems. Virtual simulations inject human-in-the-loop in a central role by exercising motor control skills (flying an airplane), decision skills (committing fire control resources to action), or communication skills (as a member of a command, control, communications, computers, and intelligence team).

o **Constructive Simulation.** A constructive simulations involves simulated people operating simulated systems. Real people stimulate (make inputs to) such simulations, but are not involved in determining the outcomes.

Collective Training. Collective training develops skills for individuals to operate as crews or teams in environments such as aircraft cockpits, command and control stations, ship bridges, and tanks.

Computer-Generated Forces. Computer-generated forces are a collection of unmanned battlefield entities under control as a unit. Computer-generated forces replace or supplement friendly, enemy, or neutral manned simulators during a specific session. The Simulation Network program uses the term "semi-automated forces" for computer-generated forces.

Computer War Game. A computer war game is a technique by which different concepts, different pieces of hardware, or different military plans can be investigated in a multi-sided confrontation using a computer to generate displays of the battlefield and to perform computations of outcomes.

Distributed Interactive Simulation. Distributed Interactive Simulation is a synthetic environment within which humans interact through a systematic connection of subcomponent simulators, simulations, instrumented live task forces, or all three. The Distributed Interactive Simulation components reside at multiple, local, and distant locations, using different simulation equipment, tied together through the use of simulation communication design. That combination of technologies collectively allows the creation of a dynamic battlefield that portrays a realistic military operational environment.

High-Level Architecture. High-level architecture consists of major functional elements, interfaces, and design rules, pertaining as feasible to all DoD simulation applications, and providing a common framework within which specific system architectures can be defined.

Individual Training. Individual training provides the skills needed to accomplish particular jobs.

Intelligent Forces. The Defense Advanced Research Projects Agency funds intelligent forces to build a maximum of intelligence into the computer representations of forces.

Interactive Models. Interactive models require human participation and are sometimes called human-in-the-loop. Human participation can include decisionmaking within computer wargaming models for tactics development and battle staff training as well as human-in-the-loop weapon system simulators and trainers.

Interface. Interface is the interconnection between two pieces of hardware or software. Interface is also a device or piece of software that accomplishes such a connection.

Modular Semi-Automated Forces. Modular semi-automated forces are a class of computer-generated forces that use a modular software structure in which model components have well-defined and documented interfaces that allow run-time reconfiguration of model behavior to develop generalized and more sophisticated representations of reactive behaviors and missions. The modular semi-automated forces provide an open architecture that is expected to be the starting point for future semi-automated forces capabilities.

Real Time. In modeling and simulation, simulated time advances at the same rate as actual time, or real time; for example, running the simulation for one second results in the model advancing time by one second.

Simulation Network. The simulated network is the Defense Advanced Research Projects Agency and Army simulation networks in which simulators can be connected over local and wide-area networks to create a simulated battlefield. The simulation network was the forerunner to the distributed interactive simulation architecture.

Simulation. Simulation is a method for implementing a model over time. Also, simulation is a technique for testing, analysis, or training in which real-world systems are used, or in which a model reproduces real-world and conceptual systems.

Simulator. A simulator is a device, computer program, or system that performs simulation. For training, it is a device that duplicates the essential features of a task situation and provides for direct practice. For distributed interactive simulation, a simulator is a physical model or simulation of a weapon system, set of weapon systems, or piece of equipment that represents some major aspects of the equipment's operation.

Synthetic Environments. Synthetic environments represent present or future factory-to-battlefield environments generated by models, simulations, and war games. They may include a mix of real and simulated objects accessible from widely dispersed locations. They are one of the science and technology thrust areas.

Appendix D. Summary of Training Simulations Reviewed

Department of the Army

Advanced Gunnery Training System. The Advanced Gunnery Training System consists of stand-alone simulators with visual systems and a motion-base that will train M1A1, M1A2, M2/M3A3 and Armored Gun System gunners and commanders in a crew setting.

Brigade/Battalion Simulation. The Brigade/Battalion Simulation is a constructive battle simulation that supports the collective training of commanders, battle staff, command posts, and headquarters of combat and combat support battalions and brigades. The life-cycle operating costs total $378 million.

Guard Unit Armory Device Full Crew Interactive Simulation Trainer-Armor. The simulation is a tank-appended, full crew training device that the Reserves use for collective tank crew training in the M1 tank. The expected cost for the simulation over its 20-year life-cycle is $115 million.

Intelligence/Electronic Warfare Tactical Proficiency Trainer. The Intelligence/Electronic Warfare Tactical Proficiency Trainer will provide individual, crew, and system training on tactical signal, imagery, and human intelligence specialties. The system simulates a radio frequency signal environment containing threat communications and noncommunications signals.

Precision Gunnery System. The Precision Gunnery System is a laser-based, vehicle-appended gunnery training system for simulating Bradley gunnery.

Tank Weapons Gunnery Simulation System. The Tank Weapons Gunnery Simulation System will develop, maintain, and objectively evaluate crew and unit proficiency in main gun skills. The Tank Weapons Gunnery Simulation System is a vehicle-appended, laser gunnery training system for simulating main gun/coax firing for M1-series tanks. The estimated 15-year life-cycle cost for the system will be $278 million dollars (constant FY 1992 dollars).

Army Warfighter's Simulation 2000. The WARSIM 2000 is a next-generation battle simulation to be used as a replacement to the current Brigade/Battalion Simulation and Corps Battle Simulation in supporting

battalion through theater-level commanders with an advanced, computer-assisted exercise system that links the virtual, live, and constructive environments. Costs total about $507 million.

Combined Arms Tactical Trainers. The Combined Arms Tactical Trainer is a network of simulators and emulators that replicate the vehicles and weapon systems of close combat, aviation, air defense, engineer, combat service support, and artillery forces. Funding is delayed to FY 2002.

Air Defense Combined Arms Tactical Trainer. The Air Defense Combined Arms Tactical Trainer is a network simulation system that allows forward area air defense units to train in collective tasks associated with the support of mechanized and armor maneuver units.

Aviation Combined Arms Tactical Trainer. The Aviation Combined Arms Tactical Trainer is a networked simulation system that allows for individual, crew, collective, and combined arms training. The Aviation Combined Arms Tactical Trainer will comprise the AH-64 Attack Helicopters; RAH-66, CH-47, OH-58D, and UH-60 helicopter systems.

Close Combat Tactical Trainer. The Close Combat Tactical Trainer is a networked simulation system that allows mechanized infantry and armor units to conduct tactical maneuver training in a combined arms, computer-simulated combat environment. The Close Combat Tactical Trainer is composed of various simulators replicating combat vehicles, tactical vehicles, and weapon systems of a heavy maneuver company or team interacting in real time with each other and semi-automated force opposing forces. Program costs total approximately $846 million.

Engineer Combined Arms Tactical Trainer. The Engineer Combined Arms Tactical Trainer is a networked simulation system that allows engineer units to train in collective tasks associated with command and control, mobility, countermobility, and survivability on a simulated interactive battlefield.

Fire Support Combined Arms Tactical Trainer. The Fire Support Combined Arms Tactical Trainer is a networked simulation system that will provide combined arms collective training for field artillery units. It provides training of the field artillery gunnery team (forward observer, fire direction, and firing battery personnel) and feedback on proficiency while conserving fuel and ammunition.

Department of the Navy

Battle Force Tactical Trainer. The Battle Force Tactical Trainer will provide the Navy with a tactical training system to maintain and assess fleet combat proficiency in all warfare areas, to include joint operations. The Battle Force Tactical Trainer will provide training at both the single platform and the Battle Group levels. Program costs will total about $165 million.

Fast Fleet. The Fast Fleet program will provide a representation of Navy platforms (carrier battle groups, carrier air wing, amphibious ready group, and mine and countermine platforms and systems) and behaviors operating in a synthetic environment for STOW 97. The funding for FY 1996 is $1 million

"Ohio" Class Ship Control Team Trainer. The "Ohio" Class Ship Control Team Trainer is a submarine warfare training program that provides a range of instruction from basic instrument familiarization and ship maneuvering to full command and control exercises.

Submarine Command Team Trainer-Fast Attack. The Submarine Command Team Trainer-Fast Attack is a submarine warfare training program that provides the submarine command team with training in all phases and aspects of target approach and attack. The system includes team and basic operator trainers. The trainers feature fire control and sonar systems.

Submarine Command Team Trainer-Trident. The Submarine Command Team Trainer-Trident is a submarine warfare training program that is designed to maintain proficiency and increase crew effectiveness in tactical situations through advanced simulation.

Control Team Trainer. The Control Team Trainer simulates the Trident submarine tactical environment, which consists of ocean model, contacts, weapons, sonar, and countermeasures.

Mark 18 Defensive Weapons Operator Trainer. The Mark 18 Defensive Weapons Operator Trainer trains personnel in countermeasures, procedures, and tactics.

Trident Sonar Maintenance Trainer. The Trident Sonar Maintenance Trainer offers intermediate and advanced instruction in sonar system maintenance, repair, and calibration.

Department of the Air Force

B-2. The B-2 aircraft training simulators are system-specific and have a total program cost of $1.5 billion.

F-22. The F-22 aircraft training simulators are system-specific and have an estimated total program cost of $747.9 million.

Soar. The Soar program will provide a representation of Air Force platforms operating in a synthetic environment for STOW 97. The funding for FYs 1995 and 1996 totals $2.8 million

T-1. The T-1 Tanker-Transport Training System is a total pilot training system designed to meet the operational requirements to implement specialized undergraduate pilot training.

Marine Corps

LeatherNet. The LeatherNet Project represents the amphibious component of a Joint Task Force in the Defense Advanced Research Projects Agency-sponsored STOW 97 initiative. Specifically, LeatherNet represents lower-echelon command and control; develops individual combatant synthetic forces; and implements advanced environmental effects.

Joint Programs

Joint Simulation System. The JSIMS will be a core of common and joint representations providing a capability to simulate the actions and interaction of all entities (such as platforms, weapons, sensors, units, command, control, communications, computers, and intelligence systems) with a designated area of operations as influenced by the environment, system capability, and human and organizational behavior affecting the achievement of missions and objectives for that area of operations. Total program funding for JSIMS is $641 million.

Navy Joint Tactical Combat Training System (JTCTS). The JTCTS is a joint system between the Navy and the Air Force with the Navy as the lead organization. The JTCTS will create a virtual simulation at the battle group level in which combat participants will interact with live and simulated targets that platform sensors detect and display. Production options bring the total expected cost for the initial systems to about $270 million.

Joint Warfare System. The Joint Warfare System focuses on the construction of synthetic environments to aid in force structure analysis, acquisition analysis, and commander-in-chief course of action analysis.

Synthetic Theater of War. The Synthetic Theater of War (STOW) program focuses on the construction of synthetic environments for numerous defense functions. The primary objective of the effort will be to integrate virtual simulation (troops in simulators fighting on synthetic battlefields), constructive simulation (wargames), and live maneuver (operations with real equipment in the field) to provide a training environment for various levels of exercises. Total funding for the STOW is approximately $500 million.

Appendix E. Calculations of Payback Period

The following table shows our calculations of the payback periods for the CCTT, WARSIM 2000, and FSCATT. We used data prepared by the Army Training and Doctrine Command that summarized investment data (outflows) for research, development, test, and evaluation; procurement; and operation and maintenance for the time period from FY 1995 through FY 2003. We also used estimated benefits (inflows) prepared by the Army Training and Doctrine Command for the time period from FY 1997 through FY 2030 for CCTT, WARSIM, and FSCATT.

Specifically, for the CCTT, the estimated benefits would be derived from reduced operation and maintenance costs based on an OPTEMPO reduction of 59.64 miles per tank and a reduction of 60 miles for other mechanized vehicles. For WARSIM, the estimated benefits would be derived from reduced operation and maintenance costs resulting from a reduction in travel and temporary duty expenses. For the FSCATT, the estimated benefits would be derived from a combination of reduced operations and maintenance costs resulting from an OPTEMPO reduction of 20 miles per howitzer and 12 artillery rounds per tube.

Our analysis indicates that at a discounted rate of 7 percent, the CCTT, WARSIM, and FSCATT programs would not achieve breakeven by the year 2030, and would, in fact, increase costs by about $818 million over that same time period. In fact, even before discounting the investment and resulting benefits, the continuing operation and maintenance costs of $55.1 million per fiscal year would exceed the estimated benefits of $52.9 million per fiscal year.

Investment	FY 1995	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000
RDT&E*						
CCTT	$50.293	$ 56.501	$ 26.713	$ 3.033	$ 3.095	$ 3.082
WARSIM	4.735	10.566	24.384	34.375	36.945	27.821
FSCATT	5.755	3.947	3.929	0.000	0.000	0.000
Subtotal RDT&E	60.783	71.014	55.026	37.408	40.040	30.903
Procurement						
CCTT	31.808	30.650	78.400	94.173	117.177	14.365
WARSIM	0.000	0.000	0.000	0.000	6.960	28.894
FSCATT	0.000	0.000	17.390	20.118	28.634	25.665
Subtotal Procurement	31.808	30.650	95.790	114.291	152.771	68.924
Operation and Maintenance						
CCTT	0.000	0.700	6.600	7.000	17.500	24.800
WARSIM	0.000	0.000	0.600	0.600	4.400	23.200
FSCATT	0.000	0.000	0.400	0.700	0.900	0.900
Subtotal Operation and Maintenance	0.000	0.700	7.600	8.300	22.800	48.900
Total (Outflows)	**$92.591**	**$102.364**	**$158.416**	**$159.999**	**$215.611**	**$148.727**
Estimated Benefits						
CCTT						
Tank	0.000	0.000	(2.530)	(3.100)	(13.701)	(17.935)
Mechanized	0.000	0.000	(0.601)	(1.279)	(5.887)	(7.179)
WARSIM	0.000	0.000	0.000	0.000	0.000	0.000
FSCATT						
Miles (20 per Howitzer)	0.000	0.000	0.000	(0.030)	(0.060)	(0.010)
Rounds (12 per Tube)	0.000	0.000	(0.066)	(1.284)	(2.275)	(0.604)
Total Estimated Inflows	0.000	0.000	(3.197)	(5.693)	(21.923)	(25.728)
Net Cash Flow	92.591	102.364	155.219	154.306	193.688	122.999
Present Value Factor	1.000	0.934	0.873	0.816	0.762	0.713
Net Present Value	92.591	95.667	135.574	125.960	147.764	87.697
Cumulative Net Present Value	**$92.591**	**$1,188.258**	**$323.833**	**$449.792**	**$597.556**	**$685.252**

*Research, Development, Test, and Evaluation.

Investment	FY 2001	FY 2002	FY 2003	FY 2004	FY 2005	FY 2006
RDT&E*						
CCTT	$ 3.058	$ 0.000	$ 0.000	$ 0.000	$ 0.000	$ 0.000
WARSIM	21.389	16.200	18.200	0.000	0.000	0.000
FSCATT	0.000	0.000	0.000	0.000	0.000	0.000
Subtotal RDT&E	24.447	16.200	18.200	0.000	0.000	0.000
Procurement						
CCTT	7.660	0.000	0.000	0.000	0.000	0.000
WARSIM	29.997	3.784	0.500	0.000	0.000	0.000
FSCATT	16.686	0.000	0.000	0.000	0.000	0.000
Subtotal Procurement	54.343	3.784	0.500	0.000	0.000	0.000
Operation and Maintenance						
CCTT	29.700	33.000	33.900	33.900	33.900	33.900
WARSIM	23.100	26.800	20.200	20.200	20.200	20.200
FSCATT	1.000	1.000	1.000	1.000	1.000	1.000
Subtotal Operation and Maintenance	53.800	60.800	55.100	55.100	55.100	55.100
Total Invest(Outflows)	**$132.590**	**$80.784**	**$73.800**	**$55.100**	**$55.100**	**$55.100**
Estimated Benefits						
CCTT						
Tank	(19.069)	(19.069)	(19.069)	(19.069)	(19.069)	(19.069)
Mechanized	(7.409)	(7.409)	(7.409)	(7.409)	(7.409)	(7.409)
WARSIM	0.000	0.000	(26.000)	(26.000)	(26.000)	(26.000)
FSCATT						
Miles (20 per Howitzer)	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)
Rounds (12 per Tube)	(0.429)	(0.429)	(0.429)	(0.429)	(0.429)	(0.429)
Total Estimated Inflows	(26.917)	(26.917)	(52.917)	(52.917)	(52.917)	(52.917)
Net Cash Flow	105.673	53.867	20.883	2.183	2.183	2.183
Present Value Factor	0.666	0.622	0.582	0.543	0.508	0.475
Net Present Value	70.414	33.546	12.154	1.187	1.110	1.037
Cumulative Net Present Value	**$755.667**	**$789.213**	**$801.367**	**$802.554**	**$803.664**	**$804.701**

*Research, Development, Test, and Evaluation

Investment	FY 2015	FY 2020	FY 2025	FY 2030
RDT&E*				
CCTT	$ 0.000	$ 0.000	$ 0.000	$ 0.000
WARSIM	0.000	0.000	0.000	0.000
FSCATT	0.000	0.000	0.000	0.000
Subtotal RDT&E	0.000	0.000	0.000	0.000
Procurement				
CCTT	0.000	0.000	0.000	0.000
WARSIM	0.000	0.000	0.000	0.000
FSCATT	0.000	0.000	0.000	0.000
Subtotal Procurement	0.000	0.000	0.000	0.000
Operation and Maintenance				
CCTT	33.900	33.900	33.900	33.900
WARSIM	20.200	20.200	20.200	20.200
FSCATT	1.000	1.000	1.000	1.000
Subtotal Operation and Maintenance	55.100	55.100	55.100	55.100
Total (Outflows)	**$55.100**	**$55.100**	**$55.100**	**$55.100**
Estimated Benefits				
CCTT				
Tank	(19.069)	(19.069)	(19.069)	(19.069)
Mechanized	(7.409)	(7.409)	(7.409)	(7.409)
WARSIM	(26.000)	(26.000)	(26.000)	(26.000)
FSCATT				
Miles (20 per Howitzer)	(0.010)	(0.010)	(0.010)	(0.010)
Rounds (12 per Tube)	(0.429)	(0.429)	(0.429)	(0.429)
Total Estimated Inflows	(52.917)	(52.917)	(52.917)	(52.917)
Net Cash Flow	2.183	2.183	2.183	2.183
Present Value Factor	0.258	0.210	0.210	0.210
Net Present Value	0.564	0.460	0.460	0.460
Cumulative Net Present Value	**$811.458**	**$813.859**	**$816.162**	**$818.464**

*Research, Development, Test, and Evaluation

Appendix F. Operating Tempo Reductions to Achieve Breakeven Position Over the 15-Year Life of the Close Combat Tactical Trainer

This appendix shows our calculations of the required OPTEMPO reductions that would have to be obtained for the CCTT to achieve a breakeven position over its estimated useful life of 15 years. According to data supplied by Army Training and Doctrine Command, OPTEMPO vehicle miles would have to be reduced by about 199.4 miles for tanks and by 200.6 miles for mechanized vehicles for CCTT to achieve breakeven by FY 2015 using a discounted rate of 7 percent.

The Army Training and Doctrine Command analysis used a baseline of 800 miles per tank per year and estimated OPTEMPO reductions from that baseline. However, the actual miles of operational funding at the unit level is significantly less than 800 miles per tank per year. The Army analysis is unclear as to whether the anticipated reductions can be made from a lower baseline. For example, at Fort Riley, the miles funded for FY 1996 were less than 600 miles per tank per fiscal year. Therefore, for CCTT to reach a breakeven position over its estimated useful life of 15 years, the actual funded OPTEMPO vehicle miles would have to be reduced to a level of about 400 miles per vehicle per year to generate sufficient "out of pocket" savings at the unit level through the use of CCTT.

Appendix F. Operating Tempo Reductions to Achieve Breakeven Position Over the 15-Year Life of the Close Combat Tactical Trainer

	Dollars in Millions					
Investment	FY 1995	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000
RDT&E*	$50.293	$ 56.501	$ 26.713	$ 3.033	$ 3.095	$ 3.082
Procurement	31.808	30.650	78.400	94.173	117.177	14.365
Operation and Maintenance	0.000	0.700	6.600	7.000	17.500	24.800
Total (Outflows)	**$82.101**	**$87.851**	**$111.713**	**$104.206**	**$137.772**	**$42.247**
Estimated Benefits						
Tank (199.4 miles)	0.000	0.000	(8.458)	(10.363)	(45.802)	(59.957)
Mechanized (200.6 miles)	0.000	0.000	(2.009)	(4.276)	(19.680)	(23.999)
Total Inflows	**0.000**	**0.000**	**(10.467)**	**(14.639)**	**(65.482)**	**(83.956)**
Net Cash Flow	82.101	87.851	101.246	89.567	72.290	(41.709)
Present Value Factor	1.000	0.934	0.873	0.816	0.762	0.713
Net Present Value	82.101	82.104	88.432	73.113	55.150	(29.738)
Cumulative Net Present Value	**$82.101**	**$164.205**	**$252.637**	**$325.750**	**$380.900**	**$351.162**

*Research, Development, Test, and Evaluation.

Appendix F. Operating Tempo Reductions to Achieve Breakeven Position Over the 15-Year Life of the Close Combat Tactical Trainer

Dollars in Millions

Investment	FY 2001	FY 2002	FY 2003	FY 2004	FY 2005	FY 2006
RDT&E*	$ 3.058	$ 0.000	$ 0.000	$ 0.000	$ 0.000	$ 0.000
Procurement	7.660	0.000	0.000	0.000	0.000	0.000
Operation and Maintenance	29.700	33.000	33.900	33.900	33.900	33.900
Total (Outflows)	**$40.418**	**$33.000**	**$33.900**	**$33.900**	**$33.900**	**$33.900**
Estimated Benefits						
Tank (199.4 miles)	(63.748)	(63.748)	(63.748)	(63.748)	(63.748)	(63.748)
Mechanized (200.6 miles)	(24.768)	(24.768)	(24.768)	(24.768)	(24.768)	(24.768)
Total Inflows	**(88.516)**	**(88.516)**	**(88.516)**	**(88.516)**	**(88.516)**	**(88.516)**
Net Cash Flow	(48.098)	(55.516)	(54.616)	(54.616)	(54.616)	(54.616)
Present Value Factor	0.666	0.622	0.582	0.543	0.508	0.475
Net Present Value	(32.050)	(34.573)	(31.787)	(29.707)	(27.764)	(25.948)
Cumulative Net Present Value	**$319.112**	**$284.540**	**$252.753**	**$223.045**	**$195.281**	**$169.334**

*Research, Development, Test, and Evaluation

Appendix F. Operating Tempo Reductions to Achieve Breakeven Position Over the 15-Year Life of the Close Combat Tactical Trainer

	Dollars in Millions					
Investment	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011	FY 2012
RDT&E*	$ 0.000	$ 0.000	$ 0.000	$ 0.000	$ 0.000	$ 0.000
Procurement	0.000	0.000	0.000	0.000	0.000	0.000
Operation and Maintenance	33.900	33.900	33.900	33.900	33.900	33.900
Total (Outflows)	**$33.900**	**$33.900**	**$33.900**	**$33.900**	**$33.900**	**$33.900**
Estimated Savings						
Tank (199.4 miles)	(63.748)	(63.748)	(63.748)	(63.748)	(63.748)	(63.748)
Mechanized (200.6 miles)	(24.768)	(24.768)	(24.768)	(24.768)	(24.768)	(24.768)
Total Inflows	**(88.516)**	**(88.516)**	**(88.516)**	**(88.516)**	**(88.516)**	**(88.516)**
Net Cash Flow	(48.098)	(55.516)	(54.616)	(54.616)	(54.616)	(54.616)
Present Value Factor	0.444	0.415	0.387	0.362	0.338	0.316
Net Present Value	(24.250)	(22.664)	(21.181)	(19.795)	(18.500)	(17.290)
Cumulative Net Present Value	**$145.083**	**$122.420**	**$101.239**	**$81.443**	**$62.943**	**$45.653**

*Research, Development, Test, and Evaluation

	Dollars in Millions		
Investment	FY 2013	FY 2014	FY 2015
RDT&E*	$ 0.000	$ 0.000	$ 0.000
Procurement	0.000	0.000	0.000
Operation and Maintenance	33.900	33.900	33.900
Total (Outflows)	**$33.900**	**$33.900**	**$33.900**
Estimated Benefits			
Tank (199.4 miles)	(63.748)	(63.748)	(63.748)
Mechanized (200.6 miles)	(24.768)	(24.768)	(24.768)
Total Inflows	**(88.516)**	**(88.516)**	**(88.516)**
Net Cash Flow	(54.616)	(54.616)	(54.616)
Present Value Factor	0.295	0.276	0.258
Net Present Value	(16.159)	(15.102)	(14.114)
Cumulative Net Present Value	**$29.494**	**$14.392**	**$0.278**

*Research, Development, Test, and Evaluation

Appendix G. Report Distribution

Office of the Secretary of Defense

Under Secretary of Defense for Acquisition and Technology
  Director for Test, Systems Engineering and Evaluation
  Director, Defense Modeling and Simulation Office
  Deputy Under Secretary of Defense (Acquisition Reform)
  Director, Defense Logistics Studies Information Exchange
Under Secretary of Defense (Comptroller)
  Deputy Chief Financial Officer
  Deputy Comptroller (Program/Budget)
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Assistant Deputy Chief of Staff for Training
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Commander, U.S. Army Simulation, Training and Instrumentation Command
Commander, U.S. Army Forces Command
Commander, U.S. Army Training Support Center
Commander, National Training Center
Commander, 1st Infantry Division
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Department of the Navy

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Deputy Chief of Naval Operations (Resources, Warfare Requirements, and Assessment)
Assistant Secretary of the Navy (Financial Management and Comptroller)
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Director, Joint Training and Simulation Center
Commander, U.S. Naval Space and Electronic Warfare Command
Commander, U.S. Naval Air Systems Command
Commander, U.S. Naval Sea Systems Command
Commander, Naval Air Warfare Center Training Systems Division
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Commander, Fleet Combat Training Center Atlantic
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Commander, Naval Command, Control and Ocean Surveillance Center
Commander, Naval Air Station Miramar
Auditor General, Department of the Navy
Director of Naval Training
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Marine Corps

Commander, Marine Corps Air Ground Combat Center
Director, Modeling and Simulation Management Office

Unified Command

Commander in Chief, U.S. Atlantic Command

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Senate Subcommittee on Defense, Committee on Appropriations
Senate Committee on Armed Services
Senate Committee on Governmental Affairs
House Committee on Appropriations
House Subcommittee on National Security, Committee on Appropriations
House Committee on Government Reform and Oversight
House Subcommittee on Government Management, Information, and Technology, Committee on Government Reform and Oversight
House Subcommittee on National Security, International Affairs, and Criminal Justice, Committee on Government Reform and Oversight
House Committee on National Security

Part III - Management Comments

Under Secretary of Defense for Acquisition and Technology Comments

ACQUISITION AND TECHNOLOGY

THE UNDER SECRETARY OF DEFENSE
3010 DEFENSE PENTAGON
WASHINGTON, D.C. 20301-3010

MAR 17 1997

MEMORANDUM FOR OFFICE OF THE INSPECTOR GENERAL, DoD (OIG, DoD)
(ATTENTION: DIRECTOR, ACQUISITION MANAGEMENT)

SUBJECT: Response to OIG, DoD, Draft Audit Report, "Requirements Planning for Development, Test, Evaluation, and Impact on Readiness of Training Simulators and Devices," Project No. 5AB-0070.00, January 10, 1997

Thank you for the opportunity to review and comment on your January 10, 1997, draft audit report, subject as above. This is a coordinated response with the Undersecretary of Defense for Personnel and Readiness and the Assistant Secretary of Defense for Command, Control, Communications and Intelligence. We agree in principle with the audit's desire for more effective oversight of training simulation acquisitions. Overall, the audit is timely and helpful for initiating the Department's next steps in the area of modeling and simulation management. While we cannot agree with each of the findings and recommendations, we are committed to taking appropriate actions to ensure a positive impact on simulation management, support, and effectiveness across all DoD Components. Our specific comments on the subject report's findings, recommendations, monetary benefits, and material control weaknesses are attached.

We appreciate the exchanges we have had with members of the OIG audit team and thank them for their diligence. This audit will make a positive contribution to improving DoD's management of training simulations. Please incorporate this memorandum, along with the attachment, in the final audit report.

Paul Kaminski
Paul G. Kaminski

Attachment
As stated

cc:
Component Acquisition Executives
OUSD(A&T)
USD(P&R)
ASD(C3I)
CJCS
DoD EXCIMS

Response to Office of the Inspector General (OIG), DoD Draft Audit Report "Requirements Planning for Development, Test, Evaluation, and Impact on Readiness of Training Simulators and Devices" Project No. 5AB-0070.00 January 10, 1997

Finding A: "The DoD is developing and procuring large-scale computer training simulations without adequate control and oversight. Control and oversight are lacking because DoD has not assigned a single manager the responsibility and authority for oversight and coordination of large-scale training simulations. As a result, DoD senior management and decision makers have not received Major Automated Information System [(MAIS)] quarterly reporting and have not conducted milestone decision reviews for large-scale training simulations."
Response: Partially concur. We see a need to improve the management of such procurements, but disagree with the audit's implication that this is due to a failure to classify these simulations as automated information systems (AISs) and conduct milestone decision reviews at the Office of the Secretary of Defense (OSD) level. On February 26, 1997, the Under Secretary of Defense for Acquisition and Technology (USD(A&T)) established policy and strategy to better manage and oversee the acquisition of large-scale training simulation systems. This strategy designates selected training simulation acquisitions as "Special Interest," delegates their management and oversight to DoD Components, initiates a program reporting mechanism, and directs program reviews by an OSD Review Team (ORT). This team will have members from the offices of the Director, Defense Research and Engineering (DDR&E), the Assistant Secretary of Defense (Command, Control, Communications, and Intelligence) (ASD(C3I)), and the Deputy Under Secretary of Defense (Readiness) (DUSD(R)). The review team will conduct semi-annual program reviews of each large-scale training simulation program to assess program status, acquisition strategy, and progress through the acquisition life-cycle.

Recommendation A.1: "We recommend that the [USD(A&T)] and the [ASD(C3I)] coordinate to:"

Recommendation A.1.a: "Assign a single DoD manager oversight of the acquisition of training simulation acquisition programs as well as systems of systems."
Response: Concur. USD(A&T) has established policy and strategy to better manage and oversee the acquisition of large-scale training simulation systems.

DoD Directive 5000.1, "Defense Acquisition," assigns the USD(A&T) responsibility for all acquisition matters within the Department of Defense. DoD Directive 5000.59, "DoD Modeling and Simulation (M&S) Management," makes the USD(A&T) responsible for managing M&S throughout DoD, advised and assisted by an Executive Council for Modeling and Simulation (EXCIMS). Following an overarching integrated product team (OIPT) approach, the EXCIMS brings together a wide array of expertise in simulation-relevant operational and support roles across the department, with senior representatives from OSD (including the offices of the USD(P&R), the ASD(C3I), and the Director of Test, Systems Engineering, and Evaluation), the Chairman of the Joint Chiefs of Staff (CJCS), and the Services.

Attachment

DoD Directive 5000.59 tasks the EXCIMS to oversee development of DoD M&S policies, plans, programs, publications, and procedures; encourage improved communication and coordination among DoD M&S activities; identify investments in M&S that have high value return in fulfilling DoD requirements, or that fill gaps in M&S capabilities; and promote joint and cooperative research, development, acquisition, and operation of M&S systems, technologies, and capabilities among DoD components. While these EXCIMS duties are extensive, we agree with the audit's observation that "additional improvements are needed," for to date the EXCIMS' review of individual simulation acquisition programs has been limited. However, we believe that it can effectively do so through the above-mentioned OSD Review Team, functioning in conjunction with this body and accommodating appropriate DoD Chief Information Officer (CIO) oversight.

The USD(A&T) and the EXCIMS are pursuing a comprehensive strategy, embodied in the DoD 5000.59-P, "Modeling and Simulation (M&S) Master Plan," to foster the development of simulation systems of systems (also known as federations). Key to this strategy is establishment of a DoD-wide Common Technical Framework for simulations, including the High Level Architecture.

Recommendation A.1.b: "Clarify the scope of the definition of an automated information system in DoD Regulation 5000.2-R, 'Mandatory Procedures for Major Defense Acquisition Programs (MDAPS) and Major Automated Information System (MAIS) Acquisition Programs,' March 15, 1996, to define specifically the size and type of systems that are under the cognizance of the [USD(A&T)] and those systems that are under the cognizance of the [ASD(C3I)]."
Response: Partially concur. Since information technology is used extensively in almost all modern systems, it is doubtful that any definition will be satisfactory to settle all questions regarding this matter. The approach described in our response to Finding A and Recommendation A.1.a. provides a useful template for other classes of systems.

Recommendation A.1.c: "Define the acquisition category for the purpose of establishing oversight of large-scale training simulations and systems of systems."
Response: Partially concur. USD(A&T) has classified large-scale training simulations as "Special Interest" and has established an ORT to periodically review them. "Systems of systems" are managed by domains and as such do not have an acquisition category. The ability of these large-scale training simulations to participate in broader simulation systems of systems will be considered by the ORT and EXCIMS.

Recommendation A.1.d: "Include the appropriate subject matter expects in exercising oversight over large-scale training simulations and systems of systems. In accordance with [paragraph 5.4 of DoD 5000.2-R], [OIPTs] should be created with participation from subject matter experts from the Under Secretary of Defense for Personnel and Readiness, the Joint Staff, the Military Departments, and the Defense Modeling and Simulation Office [DMSO]."
Response: Concur. This is precisely the concept behind the M&S management structure established under DoD Directive 5000.59; we will use the EXCIMS and the ORT to accomplish this action.

Recommendation A.1.e: "Review all ongoing training simulation acquisitions and determine whether reclassification from a lower acquisition category program to an Acquisition Category-1A program is appropriate and whether milestone decision reviews should be performed as described in [DoD 5000.2-R], 'Mandatory Procedures for Major Defense Acquisition Programs (MDAPS) and Major Automated Information System (MAIS) Acquisition Programs,' March 15, 1996."

Response: Concur. The USD(A&T) has classified large-scale training simulations cited in the OIG report as "Special Interest" and has established an OSD Review Team to periodically review them. The ORT reviews will include monitoring the performance of milestone decision reviews by the DoD Components.

Recommendation A.2: "We recommend that the [USD(A&T)] review the role of the [EXCIMS] and the [DMSO] in the oversight of modeling and simulation related programs, and consider changes to DoD Directive 5000.59, 'DoD Modeling and Simulation Management," January 4, 1994."

Response: Concur. USD(A&T) will do this within six months and, if changes to the directive are required, begin coordination on a revised version within a year.

Finding B: "The Defense Advanced Research Projects Agency and the Joint Staff have investment plans to develop redundant joint training simulations, the [Synthetic Theater of War (STOW) Advanced Concept Technology Demonstration (ACTD)] and [Joint Simulation System (JSIMS)], respectively. Neither the Defense Advanced Research Agency or the Joint Staff have determined whether the two programs meet valid requirements. By establishing an Overarching Integrated Product Team to review both simulation programs, redundant development can be prevented, thereby better using at least $209 million."

Response: Nonconcur. The STOW ACTD and the JSIMS acquisition program are different in nature, scope and purpose. They are intended to be complementary, with the STOW ACTD developing a limited-function prototype simulation system which will yield technologies and lessons learned of use to JSIMS and the broader M&S community. We are committed to ensuring both STOW and JSIMS are cost-effective investments. OSD oversight of these programs is already ongoing under the USD(A&T). The Deputy Under Secretary of Defense for Advanced Technology chairs the STOW Oversight Council, which includes a broad cross-section of representatives from DoD and the allied nation that is participating in this effort. The EXCIMS' Training Council provides oversight to JSIMS, and the DDR&E chairs the JSIMS Senior Review Board. Significant program changes have already been implemented as a result of this oversight, including the recent establishment of the STOW Advanced Simulation Technology Thrust to complement JSIMS.

Thus the existing JSIMS and STOW oversight organizations have already considered the issue of redundancy between the programs and have taken actions to eliminate redundancy and to better leverage them. However, given the evolving definition of JSIMS capabilities, emergent changes in the STOW ACTD, and our interest in ensuring cost-effective simulation, we agree that

an objective review is warranted. Hence, on February 11, 1997, the DDR&E tasked the EXCIMS Training Council, augmented by additional expertise as appropriate, to review both JSIMS and STOW, and to report back by April 23, 1997, specifically addressing the issues raised in Finding B. Representatives of the offices represented on the OSD Review Team are actively involved in this review.

We believe this review and the attendant actions that follow will effectively address the concerns raised in Finding B and its associated corrective recommendations. However, we cannot concur in Finding B because the alleged redundancy has not been established. A second reason for our non-concurrence is that JSIMS has a Joint Requirements Oversight Council (JROC)-approved Operational Requirements Document (ORD), contradicting Finding B's statement that "Neither the Defense Advanced Research Projects Agency nor the Joint Staff have determined whether the two programs meet valid requirements."

Recommendation B.1: "We recommend that the [ASD(C3I)] establish an [OIPT] to review the [STOW ACTD] and [JSIMS] program, to include the Army HeavyNet, the Navy Fast Fleet, the Air Force Semi-Automated Forces, the Marine Corps LeatherNet, the Army's Warfighter's Simulation 2000, the Navy Maritime Simulation, and the Air Force National Air and Space Model programs to determine the relationship of the two programs to each other and to determine whether both programs are needed. If it is determined that both simulation programs are needed, develop a management plan to ensure that they complement rather than duplicate each other."

Response: Partially concur. We concur with the use of an OIPT to review the STOW ACTD and JSIMS programs, to include their associated supporting programs, but believe this is most appropriately done under USD(A&T) leadership. As noted above, the EXCIMS Training Council, augmented by additional expertise from the CIO, has a review underway to address the issues raised in Finding B. The offices represented on the OSD Review Team are actively involved in this review.

Recommendation B.2: "We recommend that the [JROC] validate the requirements for the [STOW ACTD] and [JSIMS] program at the conclusion of the [OIPT] review."

Response: Nonconcur. The JROC has already validated the JSIMS ORD, as noted above. STOW does not require JROC validation because it is a science and technology (S&T) project that has been designated as an ACTD. The JROC has approved the *Joint Warfighting Science and Technology Plan* of May 1996, which states that STOW will develop and demonstrate M&S technology for major simulation development programs, such as JSIMS. The JROC has also defined and validated a set of S&T objectives derived from the Joint Warfighting Capability Assessment process. This process validates individual Defense Technology Objectives (DTOs), including the STOW ACTD (DTO F.01), to ensure that the US technology base is capable of supporting future warfighting capabilities.

Finding C: "The Military Departments have not demonstrated the effectiveness of large-scale computer training simulations being developed. Effectiveness has not been demonstrated because

requirements for performing training effectiveness evaluations, methods for accomplishing the evaluations, and the data on which to base comparisons is inadequate. As a result, DoD is investing more than $1.6 billion in large-scale computer training simulations that, if relied upon for training, may adversely affect readiness."

Response: Partially concur. It is true that the effectiveness of large-scale training simulations has not been thoroughly demonstrated in directly-measurable quantitative terms, and we agree with the intent of the attendant recommendations, that the Department should seek better means to determine the training effectiveness and cost-effectiveness of large training simulation acquisitions. However, there are ample indications that this class of investments is warranted and will provide real benefits to the operational forces.

This section of the draft audit report makes many valid observations, including the evolution in training simulation concepts, the importance of training effectiveness evaluations, the need for data on the effectiveness of current training, and the need for new analytical methods for doing effectiveness evaluations of training simulations. We would add that (1) any analyses should include impact considerations beyond operating tempo (e.g., travel cost, personnel tempo benefits, capabilities otherwise impractical), and (2) the current best judge of training effectiveness remains the military leadership.

The systematic training effectiveness evaluation of large-scale live exercises is in itself a daunting challenge. The report explicitly assumes that, despite limited data, the effectiveness of live training has been validated over an extended period of use. Curiously, the report does not apply this same criterion to training simulations. We believe the effectiveness of training simulations has likewise been validated by an extended period of operational use and that this fact explains why the Combatant Commands and Services have in general strongly supported simulation acquisition programs like JSIMS and CCTT.

We believe Finding C should have considered additional evidence of training simulation effectiveness. For instance, a May 1996 Institute for Defense Analyses report, *Utility of Modeling and Simulation in the Department of Defense: Initial Data Collection,* noted that formal evaluations have demonstrated that constructive simulations train commanders and staffs (from platoon through brigade leaders) effectively and relatively inexpensively. One of its case studies involved the United States Atlantic Command's (USACOM's) AGILE PROVIDER (AP) and UNITED ENDEAVOR (UE) exercises. Two sequential exercises involved the same training audience. The AP-94 field exercise cost $48 million, while the UE-95 exercise, conducted using the Joint Training Confederation of constructive simulations, cost $3.4 million. Approximately 85% of the UE-95 participants rated their training as good, and 82% rated the training better than a similar field exercise like AP-94. Thus the use of training simulations yielded better training at about 7% of the cost. While not an exhaustive study, such evaluations are illuminating.

The audit report also did not address guidance issued by the CJCS under his responsibility for "formulating policies for the joint training of the armed forces" under Title 10, USC, section 153. The Chairman's training policies and responsibilities are explained in three key documents: CJCS Instruction (CJCSI) 3500.01, "Joint Training Policy of the Armed Forces;" CJCSI 3500.02, "Joint Training Master Plan for the Armed Forces of the United States;" and CJCS Manual 3500.04, "Universal Joint Task List (UJTL)." These documents apply to the Joint Staff, Military Services, Combatant Commands and other activities and agencies responsive to the

Chairman. The CJCS has established five criteria which must be met to use M&S to accomplish joint training, and so bear on the strategies and requirements for training simulations.

Finally, we note the audit's presumption that training simulations must be justified in terms of what they replace. That view overlooks the benefits such simulations can have as an augment to, rather than replacement for, field training. Simulations can also allow the performance of many training tasks which might be otherwise unfeasible for reasons of cost, security, safety, environmental restrictions, or political constraints.

Recommendation C: "We recommend the [USD(P&R)]:"

Recommendation C.1: "Establish policy and procedures for evaluating the training effectiveness and cost-effectiveness of large-scale training simulations. Policy and procedures should include:

- benchmarks against which to measure the benefits of large-scale training simulations; and
- the plans, methods, and techniques to gather data on live exercises to establish a data base of training results."

Response: Concur. We remain encouraged that advanced training simulations can give our forces a key operational edge by directly supporting real-world operations and by providing the right training, in the right quantities, at the right pace, from geographically-dispersed locations. We agree that the Department should seek more formal analyses of the training effectiveness and cost-effectiveness of large training simulation acquisitions. USD(P&R) has committed to developing policy and guidelines for conducting cost-effectiveness analyses of large-scale training simulations that: (1) allow analysts to select the best method under the circumstances; (2) describe the procedures for the various methods; and, (3) provide examples that may be used as models to emulate. The USD(P&R) has also committed to establishing a historical training effectiveness data base and will ensure appropriate access to this information. The USD(P&R) will also investigate the potential to incorporate such plans and assessments in the CJCS Joint Training Plan.

Recommendation C.2: "Direct the Military Departments to perform a training effectiveness evaluation for all Acquisition Category 1A [(ACAT-1A)] programs before each milestone approval."

Response: Concur. As noted in the response to Finding A above, the USD(A&T) has already designated these programs "Special Interest," and, as such, they are not designated ACAT-1A. We will proceed with this recommendation as soon as the requisite guidelines and policies are in place.

Finding D: "The Army and the Navy have successfully cooperated in the development and acquisition of training devices, simulators, and simulations in Orlando, Florida. Those efforts have resulted in a high degree of technological synergy through the leveraging of resources."

Response: Concur. We note that the Air Force has also recently located a field operating agency in Orlando to support its simulation developments, so such interservice cooperation can be expected to improve further.

Potential Monetary Benefits, Appendix G, "Summary of Potential Benefits Resulting From Audit:" Recommendation B.1 asserts that $69.6 million in Research, Development, Test and Evaluation funds, and $139.7 million in Operations and Maintenance funds could be saved by following Recommendation B.1. These figures are apparently derived from Table 3, "STOW ACTD Funding," on page 18 of the draft audit report.

Response: Nonconcur. The majority of the Fiscal Year 1997 STOW funds are already contractually obligated and little could be recovered if the STOW ACTD were canceled at this point. The funding line cited for USACOM is to operate its Joint Training, Analysis, and Simulation Center (JTASC). Although this is the facility where the STOW ACTD training will be conducted, the JTASC funding line supports the full range of its operations, with very little related to direct support of the STOW ACTD. Thus the DoD might realize approximately $31 million in savings from canceling the STOW ACTD.

Material Management Control Weaknesses (Appendix A.): "We identified material management control weaknesses, as defined by DoD Directive 5010.38, in that DoD did not determine oversight responsibilities for training simulation acquisitions, establish procedures to prevent redundant developments of training simulations, or establish procedures for determining the effectiveness of training simulations."

Response: Partially concur. Oversight responsibility rested with the Components, the EXCIMS, and the USD(A&T) and the USD(P&R), but in the aggregate these organizations may not have fully executed their responsibilities in the most effective manner. As discussed above under Finding B, several management bodies examined the relationship between JSIMS and the STOW ACTD and took action to correct perceived problems. The alleged redundancy between these projects will be examined by the EXCIMS Training Council to determine the validity of this assertion and to craft appropriate corrective actions. Thus, the necessary oversight responsibilities and procedures were largely in place, but the actions discussed above will ensure the responsible bodies function more effectively.

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